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# Teachers College RECORD

A Journal Devoted to the Practical Problems of Elementary and Secondary Education and the Professional Training of Teachers

January, 1901


## COURSE IN BIOLOGY

## IN THE

## HORACE MANN HIGH SCHOOL


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# COURSE IN BIOLOGY IN THE HORACE MANN SCHOOL[1]

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## Preface

The courses in botany and zoölogy here presented in outline are given in the first year in the Horace Mann High School, and are followed by the courses in physics and chemistry. It is still a question whether this arrangement is the best. It has been argued by some that botany and zoölogy should come later in the high-school course for the reason that a knowledge of chemistry and physics is necessary to any understanding of the physiology of plants and animals. And this cannot be doubted. But, on the other hand, experience has shown that even when biology has been placed later in the high-school course, preceded by chemistry and physics, only a portion of the class are sufficiently familiar with those sciences to obviate a repetition of the principles in connection with their application in the biological laboratory. So far as any distinct advantage accruing to the student or teacher is concerned, therefore, the conditions are but little different from those obtaining under the present arrangement in the Horace Mann School, under which some of the pupils enter the class from the elementary school with a slight elementary knowledge of chemistry and physics, and others with none. In either case the problem of presenting the subject of biology is much the same.

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Over against the argument based on the logical sequence of the sciences is one derived from interest. It appears to be a pretty widely recognized fact that natural history generally appeals much more strongly to students of the earlier years of the high school than to those of the later years. Just why this is so need not be discussed here. This order, however, finds support in the action of the National Educational Association taken at the meeting of 1899, at which time that body took action upon the question of the order of sciences in the high-school curriculum. It may with justice be added that the plan here described was decided upon before the conclusion of that body was reached.

Four forty-five-minute periods are given each week to the work, an amount of time deemed somewhat too brief. The zoölogical part of the course is given in the first half-year, followed by the botany in the second half-year. This arrangement appears to be justified by two considerations. First, the materials for botanical work are more available on the whole in the spring than in the autumn; more especially those used in Part 2 of the course in botany, which deals with classification in a broad sense, and with ecology. Second, it would appear that the study of animals is taken up rather more eagerly by young pupils — that is of the age of twelve or fourteen — than that of plants, for the possible reason that the responses of animals are more pronounced, but more probably because the knowledge which they gain appears to them to touch their own lives more immediately. Experimentation on plants and observation of them by young students require rather more prolonged and patient attention — a kind of work which is done better after some training in biological method has been received.

The objects of the course in biology are to give training in the use of the scientific method of thought in general, more especially as applied to the study of living organisms; and to develop in the mind of the student a fair idea of the subject matter of biology, and of the economic importance of animals and plants. In attaining these more immediate ends it is expected that further results will be secured, namely the development of intelligent citizens versed in the proper ways of thinking about the organic creation and appreciative of the value of scientific effort for the amelioration of the conditions of human life.

Looking toward the attainment of the above ends, it is intended in this course to give a share of attention to the form and structure of living organisms, to their development and relationships, to their physiology and ecology, and, finally, to their economic importance. As a result of this method of treatment the student should get considerable knowledge of the appearance of many forms, and some limited information of internal structure. He should get at the same time the very important idea that the living organism is carrying on various physiological operations, that reaction between organism and environment is constantly taking place, that organisms are essentially adaptive, and that in both animals and plants there is an essential similarity to be expressed in terms of general biology. Finally, the student should get a definite knowledge of some ways in which organisms contribute to the well-being and happiness of the human race as a result of the intelligent use which man has made of them.

A brief study of the outline will show a general similarity in the two parts of the course. In each course some time is given at the beginning to a careful study of fundamental principles in preparation for an intelligent appreciation of what follows. One part, therefore, is conducted intensively; another part is less exacting as to detail, and is designed to meet the view-point of modern natural history. It should also be added that the spirit and method of the work is the same in both courses, allowing, of course, for the individuality of the instructors.

Each course is also complementary to the other. In the outline of the study of plants, for example, no specific attention is paid to the cell. This has been done already in the zoölogical part of the work, and does not need to be repeated formally when the cell is taken up in the study of the digestion, absorption and transformation of food.

A course of this kind, then, may fairly be said to justify the application of the name of General Biology to it, and as such it is claimed to possess the unity and comprehensiveness which that name demands. Little or no attempt has been made to display this in the outlines themselves, for unity, correlation and like qualities appear in the spirit and immediate treatment of the work rather than in the form.

A further point calls for mention here. The method of beginning the study of biology with the simple forms of life, and pro-

ceeding to the complex, the so-called logical method, has found no support in the Horace Mann School. The assumption that the young mind places the same value upon a given logical arrangement of scientific facts as the more mature mind, is, we believe, an educational fallacy which is refuted by the experience of many able and thoughtful teachers. For this reason, therefore, the logical method has been abandoned in favor of a method both psychological and practical.

F. E. L.
M. A. B.

## The Course in Zoölogy

By MAURICE A. BIGELOW

### A. INTRODUCTION

The accompanying outline of a course in elementary zoölogy will, perhaps, be better understood if prefaced by some discussion of the aims and of certain propositions which underlie the course.

In the opinion of the writer the various aims which have been suggested by authors on elementary zoölogy may be conveniently classified into two groups. In the first group may be classed all aims which have a direct reference to scientific training; while in the second may be included all aims relating to the acquirement of knowledge of the subject matter.

The aims in the first group, stated in a general way, have reference to the development of a scientific attitude of mind, by directing various mental processes, such as scientific observing, reasoning on the basis of demonstrated facts, exercising judgment and discrimination, and learning to appreciate demonstrated knowledge. This is not the place to attempt a complete analysis of the attitude of mind which characterizes the student of science. Enough has been said to indicate the general direction of the first group of aims. The importance of the training which this involves has long been recognized, and the discussion need not be renewed here.

It is evident in the form of the statement that the aims of the first group are not advocated as peculiar to zoölogy. It is now well recognized that all of the sciences furnish materials for developing the chief elements of the general scientific attitude

of mind. The writer accepts the opinion of many teachers that in the teaching of every science in a secondary school it should be borne in mind that, since few pupils have opportunities for the thorough study of several sciences, no occasion should be neglected for giving training in scientific observing and scientific thinking. Many educators regard such training as far more important in liberal education than the knowledge of the facts of any science. However, it is not necessary in teaching a science with scientific training as one leading aim that its essential facts should be neglected, for the training depends largely upon the method of teaching rather than upon the subject matter. The realization of these aims is found in the general method of modern science — the laboratory method; but the quality of the training depends upon the way in which the laboratory work is directed. If the aims of the first group are to meet with the greatest possible realization, it is necessary that they be kept in mind while planning a laboratory course in zoölogy, for very much depends upon the manner in which problems for solution are presented to the minds of the pupils.

Aside from the training in mental processes which the study of zoölogy may give the pupil, there is an important phase in which zoölogy stands upon its own merits as a science with subject matter, some knowledge of which is believed to form a valuable part of liberal education. The second group of aims — second only in order of statement — is concerned with the acquirement of important facts and ideas of zoölogy.

In selecting the subject matter for an elementary course in zoölogy for secondary schools, the field of zoölogical knowledge should be viewed from the standpoint of liberal education, as distinguished from special or technical education. The field is wide, and at best only a glimpse of animal structure and life can be given in a single course. Bearing in mind that the great majority of secondary pupils can never follow more than one course of instruction in the subject, the problem is to fill that one course with those zoölogical facts and ideas which have the closest relation to the every-day life of a liberally educated man. In the future it should be recognized more clearly than in the past that many phases of the science of zoölogy, which are of interest and importance to the specialist, may have no definite meaning to a man in other walks of life. Many teachers of zoölogy in secondary

schools do not seem to have examined the subject in this light, and as a result elementary zoölogy has been too often taught as if it were the aim to train the pupils for professional work in zoölogy or in some of its direct applications, such as medicine. This special or technical training is the proper work of colleges, and has no more place in the secondary school than have higher applied mathematics.

The wide difference between the aims which govern the zoölogical teaching in colleges and those which should underlie the work in the secondary school needs to be emphasized, for already there have been too many attempts to transfer college courses and books into the secondary school. It is not a question of how near an approach can be made to the college introductory courses in zoölogy, but a question of the value of such work in liberal secondary education. Is it the most valuable which can be selected from the wide field of zoölogy? This is the really vital question which apparently has been asked by few of those who have prepared outlines of study for elementary zoölogy in secondary schools.

The course in elementary zoölogy which in the past decade has been followed in the majority of schools consists largely of detailed comparative study of the anatomy of a series of animals. It is a very close imitation of a common introductory course for college students. Several published books well represent this morphological course, and one who examines carefully is forced to conclude that very much of the subject matter is so technical and detailed as to be of very doubtful value to a liberally educated man who has no special reason for being learned in zoölogical science. In such a course there is no time for the pupil to learn anything about the life of animals or even the existence of many important animals, and, as usually conducted with preserved specimens, it is far from being a study of animal life. It is evident that the course under discussion will give pupils who follow it an extremely narrow view of the animal kingdom in its varied aspects.

The introductory college course in zoölogy from the morphological standpoint is usually followed by other courses in which other phases of zoölogy are considered, and in the end the students may gain a broad view of the field of zoölogy, and learn to think of animals in the various aspects of their structural and

functional relations. In the college system the student is expected to acquire much technical information while he is getting a general view of the field of zoölogy. In the secondary school the technical matter is undesirable, but the general view is of great importance, and in one short course within a single year (usually a half-year) must be included all that the majority of pupils are ever to be taught about animals. Are we not justified in concluding that an isolated course from the standpoint of comparative anatomy, while perhaps well adapted to the college system, fails to give the wide view of animals which is desirable in liberal education, and, therefore, does not meet the needs of the majority of secondary pupils?

It is now sometimes urged in defense of the course in anatomy that the working out of details of structure tends to give valuable scientific training. But much of this is purely special training, and the facts of detail are only of technical value. There is a growing belief among naturalists that much of the anatomical study in secondary courses can be replaced with more important subject matter, and this with no loss so far as efficiency in developing scientific observing and thinking is concerned.

In so far as it deals with the great facts of animal structure, the anatomical course has many good features which commend it for secondary education; but in so far as stress is placed upon details and comparisons of number, minute structure, exact extent, and position of organs in some half dozen types of animals, the study must be regarded not only as of little importance in liberal secondary education, but also as using time which should be devoted to undoubtedly more important phases of zoölogical study. But since the study of general anatomical structure is important as giving a basis for other phases of zoölogical study, therefore it is necessary that this much of the morphological course should be retained.

Within recent years there has been a reaction and a decided tendency towards abandoning many of the characteristic features of the morphological course, and returning towards the old-time natural history course. This reaction is best expressed by the recent *Introduction to Zoölogy* by Davenport. Such a course, as usually presented, has little or nothing to do with the study of internal structures of animals, and consequently there can be no scientific consideration of the fundamental physiological processes.

Emphasis is placed on study of external form, classification, movements, habitats and life histories of animals. Such studies of animal life and its relations are especially valuable in preparation for college courses which are largely composed of those phases of zoölogy which have little concern with natural history. The college and secondary courses under such a system would be supplementary with no repetition, and in the end those students who take both college and secondary courses in zoölogy may have a broad view of animal structure, function and life. There can be little doubt that the course in natural history is valuable in preparation for the more advanced work in the college, but it may well be doubted whether such a course is altogether the best for secondary work when considered from the standpoint of liberal education. In the omission of all reference to the general facts of internal structure and functions, has not the reaction from the purely morphological course been too extreme?

In secondary work the important physiological side of zoölogy has received but little attention, as compared with that given to natural history and morphology. In the types of elementary courses which have been discussed, there is often some mention of comparative physiology, or some observational work on responses to external stimuli; but, on the whole, physiology can hardly be considered as one of the characteristic features in the usual examples of either of the two types of courses. The fundamental physiological relations of the internal machine of the animal body have been neglected almost universally, but they should be as characteristic as any other feature of an elementary course.

The importance of interpreting the activities of the human body from the comparative standpoint seems sufficient reason for advocating the consideration of the fundamental principles of physiological action in connection with the study of elementary zoölogy. Experience has convinced the writer that there is no more profitable study for secondary pupils than the physiological side of animals. No other phase of zoölogical study arouses a deeper interest and appreciation or is more spontaneously applied by the pupils in connection with study of their own life activities. It is scarcely necessary to offer a stronger reason for including such study in an elementary course.

Summarizing the review of the ordinary types of courses in

elementary zoölogy, we must recognize that there are important features in both the morphological and the natural history courses, but when standing alone each is extreme. Each has fundamental facts and ideas which are of interest in liberal education, and also in each there are numerous details which have only special or technical value. From this follows the suggestion that the essential and valuable features of the two courses may be selected and incorporated into one. But this is not sufficient, for it has been pointed out that the very important physiological side of zoölogy deserves attention, which neither of the ordinary courses gives. The course, then, which will meet the demands of liberal education should be a study of animals from the combined aspects of the fundamentals of morphology, physiology and natural history. This statement must not be misinterpreted. To a naturalist each of the three fields is much too wide even for a lifelong study, but it must be kept in mind that the problem in secondary work is to give the pupils the most valuable ideas of animals, and the widest view of animal life. The demand of liberal education is for a broad attitude of mind towards animals, and good general ideas of the fundamentals of zoölogy. The vast masses of facts of detail which interest the naturalist must be reserved for special study by those who have time and special reasons for advanced study of the science.

Among the minor problems involved in arranging a course combining the essentials of the various phases of zoölogy, the first and most difficult one is concerned with the inclusion of physiological work in the course in elementary zoölogy. By physiological the reference here is directly to the essential processes in the general metabolism of the animal body, and the term is not limited to the mere work of observing a few movements and responses to stimuli which constitutes the great part of the so-called physiological study in many elementary courses. The study of fundamental physiological processes obviously admits of very little practical work in a direct line, and the facts must be presented by text-book and teacher. But the morphological basis for such can be strictly practical, and a logical presentation should lead the pupils from observed facts to conclusions, so that the discussion of the subject of general physiology of animals may be of far more value than a mere didactic exercise.

The usual objection to physiological work in secondary

schools is that the subject cannot be presented by a strictly laboratory method. But how much physiology does the advanced student get directly from his own laboratory studies, as compared with what he accepts on the authority of teacher and books? In how many colleges is the laboratory method *strictly* and *exclusively* applied in biological teaching? The evident answer to these questions shows how weak is the argument that only strictly practical work should be included in elementary zoölogy in secondary schools.

In combining physiology with the morphological work of the course in zoölogy, it is important that the two phases of study be closely related throughout the course. The few text-books and teachers' outlines which merely suggest the tendency towards a union of the two phases of zoölogical study seem to show that in general the attempt is tō teach physiological ideas in the form of abstract generalizations with little of concrete application to particular animals which are studied morphologically. Sometimes these generalized principles of physiology are introduced before the pupils have progressed far in the practical study of animal strucure, but more often after the completion of a purely morphological course. The latter is the case in a recent and in many respects commendable text-book and manual of elementary zoölogy by Kingsley, in the last chapter of which there is an excellent statement of the principles of comparative physiology, but there is no specific concrete application of those principles. Such a method of presenting the principles apart from concrete application is open to serious objection. In the light of experience it may well be doubted whether such presentation gives secondary pupils a clear conception of general life-activities. A physiological principle may be formulated in a generalized way, and as such may be memorized by the pupils; but that they do not grasp the ideas involved is shown by the fact that they usually fail in application when concrete cases are placed before them. Every zoölogist knows in personal experience how indefinite and unsatisfactory are the ideas gained from reading generalizations if he cannot easily recall and connect them with the specific underlying facts. In order to appreciate the attitude of the elementary pupil, it is only necessary to recognize the fact that even at the close of a half-year course the pupil has not the definite remembrance of the details of structure which are neces-

sary for concrete illustration and application of the principles of physiology. In order to give the clearest possible conception of physiological principles it is essential that structures and functions should be studied in their natural relations. The principles of physiology should be introduced with the first animal which is studied morphologically, and each principle as introduced should receive concrete application. The study can easily and quickly be made comparative as successive types of animals are taken up, and finally such specific and comparative studies may be made to lead to a direct application of the principles of comparative physiology to the activities of the human body.

Another minor but important problem which demands consideration is the much discussed question regarding the value of unicellular versus multicellular animals as types for the introductory study. Shall a course in elementary zoölogy be synthetical, beginning with unicellular animals and then progressing towards the more and more complex forms, or shall the study be analytical and, beginning with a complex multicellular animal, lead down the scale of structural and functional complexity to the simplest forms? The first named order is the one usually followed, and it is defended chiefly on the ground that it corresponds with the logical order in the development of complexity in the animal series. However much weight this may have in college work, it is doubtful whether the generalizations involved in considering animal structure and function synthetically are grasped by immature beginners in secondary schools. Moreover, an appreciation of the relations underlying the great idea of organic evolution does not necessarily depend upon a study of animals taken in the order of increasing complexity. It appears then that the argument for logical order must be regarded as insufficient.

The difficulties involved in an attempt to grasp the meaning of the structure of a protozoön are greatly complicated by the still greater difficulties which confront the beginner with the compound microscope. By use of the microscope is not meant mere mechanical manipulation, but especially accurate interpretation — a far more difficult thing for most beginners. Very many teachers consider this alone sufficient reason for *not* beginning the course of study with a microscopic form, for if the introductory type is a multicellular form of considerable size, the

use of the microscope can be learned gradually in connection with the gross examination.

The advantages of beginning the study of structure with an animal about which the pupil knows something, or at least can learn with the aid of no more uncommon apparatus than the eyes, were well stated by Huxley many years ago after he had learned by experience the great disadvantages connected with beginning zoölogical study with a microscopic animal. Many teachers in colleges have since expressed agreement with this opinion of Huxley. As applied to elementary zoölogy in secondary schools where the pupils are undeveloped, the arguments advanced by Huxley are of greater weight than when applied to college work. Pupils encounter few serious difficulties in an introductory study of the important points of structure in a complex animal. The supposed difficulties arise largely when detailed study is attempted. The general relations and the *essential* structure of organs are in the very beginning readily determined and comprehended by very young pupils.

The same arguments hold good from the physiological point of view. Every pupil knows something about the functions of his own body, and it is easy to grasp the fundamental principles of physiology when concretely applied to organs of an animal in which there is considerable physiological division of labor. It is evident that this must be a decided gain when compared with beginning physiology with a unicellular animal where all functions must be thought of abstractly in connection with a single cell. Beginning with the physiology of a multicellular animal, and considering a series of simpler forms which lead down the scale in division of labor, the pupils can understand every step of the way, and in the end will have a clearer idea of the functions of both one- and many-celled forms in their relation to the great principle of physiological division of labor.

The conclusion must be that so far as the work of secondary schools is concerned there is very little to be said in favor of introducing the course in elementary zoölogy by study of a unicellular animal, while there is much in favor of beginning with the multicellular form. The simplest animals appear to be, after all, the most complex from the young beginner's standpoint. More than this, almost everything which is supposed to argue for a logical and synthetical order of study depends upon gen-

eralizations which are not appreciated by the average secondary pupil. The experience of large numbers of teachers seems to support strongly such conclusions.

In preceding paragraphs it has been advocated that elementary zoölogy should include the most important facts and ideas of general anatomy, natural history, and the essentials of physiology. It has also been urged that physiological study should be intimately associated with morphological study from the very beginning of the course. Finally, reasons have been given for regarding multicellular animals as most favorable for introductory work which is to involve any of the above aspects of zoölogy.

Depending directly upon the foregoing conclusions, the central idea of the course in elementary zoölogy which is outlined in this paper is that of an introductory study of a complex animal examined from the several view-points of zoölogy. Such a study includes the most important facts of anatomy, histology, embryology, classification in connection with the near allies of the introductory type, distribution and ecology, general fundamental principles of physiology, habits of life, and life history. Again it may be necessary to remind the reader that this is not to be misunderstood as meaning that any one of these phases of study should go far into details. The question — What is essential for liberal education? — should be strictly applied in eliminating all that has no good reason for inclusion in the course. The writer's interpretation of what may be considered valuable in this connection will be best represented by a detailed outline of such an introductory study of one animal, and this is given in the outline of the course.

This method of introducing the study of zoölogy by a broad biological study of a single animal has long been favorably received in college work. It is unnecessary to show here that the important facts of animal structure and function can be well presented and illustrated by study of a single animal. Huxley's classical work on the crayfish, as an introduction to the study of zoölogy, gives sufficient defense of this method; and Sedgwick and Wilson have successfully applied the same idea to the earthworm. These two books have suggested the line of work which is here advocated for elementary zoölogy. Both the work of Huxley and that of Sedgwick and Wilson are far too advanced and technical for elementary pupils, but it will appear in the

general plan of the outline that these books have contributed many suggestions.

Such introductory study as has been suggested can be completed within the first five weeks of a half-year course, leaving eleven or twelve weeks in which to take a broad survey of the animal kingdom. This will be criticised on the ground that it gives too much attention to a single animal; but it will appear in the outline that most of this time is devoted to zoölogical principles capable of wide application, and which are illustrated by the careful study of a single animal. After pupils once grasp these principles, application to animals which are studied later is easily and quickly made. This method of introducing the study is designed to give pupils general ideas of the structure and activities of one animal which will aid in appreciating and interpreting any other animal. It is also intended to give intensive study of the fundamental principles of anatomy and physiology, and thus lay a foundation for a deeper acquaintance with many other animals representing important groups. Accepting the view of those naturalists who consider studies in natural history very important in liberal education, the aim is to prepare for them by including in the introductory work many of the most important topics from the other phases of zoölogy, so as to give a broader view of animals and their life than natural history alone can give. In short, the general aim is to lay a foundation which will make later study of animals, from whatever standpoint, more interesting and more intelligible, because there is included in the foundation work those great principles of animal structure and function which are of wide interest and application.

The writer is convinced that the broad view of a single animal and of some of the general principles of zoölogy, gained from the introductory study, exert a marked influence on all subsequent study of animals. Pupils with such preliminary training may be required later to study some animals from a limited point of view, for example, natural history or morphology, but their general ideas of one animal from the various points of view lead them to think of all animals as presenting illustrations of the various aspects of zoölogy. The pupils, as a rule, are eager to study every animal brought into the course as thoroughly as the introductory type was studied — that is, from the various aspects of zoölogy. Although time will not allow such extensive study

of more than one form, there is great value in such an attitude of mind with its broad outlook and interest in the various phases of animal life. This fact is mentioned here partly for the purpose of showing that interest is not lost by extended introductory work, as some critics have already urged on *a priori* grounds. Experience indicates that there is a gain rather than a loss in interest.

In conclusion it is claimed that upon a broad introductory study of one multicellular animal it is possible to base a course which combines the most valuable features of the various courses usually presented in secondary schools, and that it is possible at the same time to give as good training in scientific observing and thinking as can be done with any other course. Moreover, such a course gives a view of animals and animal life which is broader and more valuable from the standpoint of liberal education than that given by the ordinary courses which are limited to the viewpoints of either natural history or morphology. This claim is based upon the fact that such a course includes the fundamental principles of physiology in the natural relations with morphology and natural history, the importance of which relation has been discussed elsewhere.

It is not claimed that pupils who follow such a course know much about the details of comparative anatomy in a series of animals, or understand the intricacies of physiological processes, or that they store up a mass of facts from natural history; but from the standpoint of liberal secondary education stores of facts are not needed so much as broad general ideas, and an acquaintance with and interest in animals and their life.

In the preceding part of this paper there have been discussed the various problems considered during the development of the course in elementary zoölogy, which has been presented this year (1899-1900) to the first-year class in the Horace Mann High School, and which has also been outlined and discussed before the class in methods of teaching biology in secondary schools (Education 12). The course was not introduced into Teachers College as an experiment, for in its general outlines it was planned and introduced into a western academy in 1896. The general plan then proved satisfactory and has been in process of development since that year. Anticipating the objection that such a course is utterly inapplicable to the average public high school, it may be

said that in the above mentioned academy the conditions — numbers of pupils, equipment, time and development of pupils — corresponded quite closely with those of high schools; and also that the general plan of the introductory study has been tried at the writer's suggestion in a typical western high school and found satisfactory.

### B. OUTLINE OF THE COURSE IN ZOÖLOGY

## *I. A Study of the Crayfish*[1] *as an Introduction to the Study of Animals*

(Five weeks)

### 1. General External Structure of the Crayfish

(All topics preceded by an asterisk * are considered in lectures, readings and recitations, which are held in close relation with the corresponding laboratory work.[2])

General form of body, head, thorax, abdomen, appendages. Identification of anterior, posterior, dorsal, ventral, longitudinal and median, and bilateral symmetry of this and other familiar animals. Segments of the body. Skeleton. *Moulting, specimens exhibited. Outline drawings from dorsal, lateral and ventral views, labelling the chief structures represented.

Examination of the gills, attachment, number. Structure of a gill. Examine animals in which carmine has been forced to the gills from the heart and blood vessels. Drawing of animal showing position of the gills.

Examination of appendages and comparison of Appendages V to XIII and the abdominal appendages (drawings). *The principle of homology.

*Automatic amputation of appendages and regeneration, with demonstrations.

Examine lobster, prawn and crabs. In tabular form record comparisons with the crayfish. General characters of decapod crustacea. *Principles of classification. *Scientific names of animals — nomenclature. *Species, genera, orders, illustrated by decapod crustacea.

[1] The reasons for using the crayfish as an introductory type are set forth in Appendix A.

[2] Some minor methods of directing the laboratory and supplemental work are outlined in Appendix B.

Study of the living crayfish, movements, habits of life, senses.[1] Uses of the appendages, compare with the crab. Adaptations.

*Natural history. *Economic importance. *Distribution shown by colored map. *Fossil crayfishes.

Composition of 200 to 300 words on the external structure of crayfish compared with the other decapods examined.

### 2. General Internal Structure

Examination of a series of dissected specimens.

*a.* Specimens 1 and 2. Carapace removed. The exposed organs of male and female crayfish examined and drawn as seen in position.

*b.* Specimen 3. Carapace and dorsa of abdominal segments removed. Blood system injected with carmine. Heart and dorsal arteries examined and drawn with the other organs as seen in position.

*c.* Specimens 4 and 5. Carapace and heart removed. Reproductive organs in male and female. Ducts on one side dissected out. Drawings of organs as seen in position.

*d.* Specimen 6. Dissected to show digestive system. Drawing from dorsal and lateral views. Examine internal structure of alimentary canal and connection with the "liver."

*e.* Specimen 7. Dissected to illustrate muscular system. Carapace, dorsa of abdomen, stomach, heart, reproductive organs and "liver" removed. Examination of dorsal and ventral longitudinal muscles. Observe

[1] Within the limits of this outline it is impossible to specify in detail concerning the studies of the living crayfish and other animals. It should be mentioned that those experiments which give uncertain results, especially those leading to anthropomorphic interpretations, are avoided, or at least great care is taken to guard against wrong conclusions. One illustration will make this clear; for example, in the much abused experiment to test the sense of hearing in the crayfish the possibility that the reaction is produced by ordinary vibrations aside from sound waves is explained to the pupils. Similarily in experiments on taste and smell it is necessary to criticise severely results obtained by the use of irritants, such as ammonia, clove oil and like substances which authors recommend.

movement of abdomen of living animal, and compare with the arrangement of the body-muscles. Examine muscles of the great claws. Diagrams.

*f.* Specimen 8. Dissected to show excretory and nervous systems. Drawings of organs as seen in position. Demonstration of preparations of the nervous system, showing general method of distribution of nerves to organs.

*g.* Reference to the various dissections and drawings and construction of diagrams showing the relative position of organs in imaginary sagittal plane, and also in transverse planes through the heart and abdomen.

NOTE. — This exercise is designed to give practice in visualizing geometrical relations.

*h.* Tabulation of organs of the crayfish according to the systems of functions.

### 3. INTRODUCTORY MICROSCOPIC WORK AND ELEMENTARY HISTOLOGY

NOTE. — At this stage the pupils are introduced to the microscope, and, after examination of the instrument, practice with low powers is given. Most of the preparations mentioned below, which require high powers, are arranged by the instructor, and, after explanation by diagrams, the preparations are examined by the pupils, and drawings made.

Examination of preparations from various organs — liver, gill, intestine, muscle. (The aim here is to give some general ideas of tissues and cells; nothing in the line of formal histology is intended.)

*Organs, tissues and cells in animal structures. *Protoplasm.

### 4. ELEMENTARY EMBRYOLOGICAL STUDY

Demonstrations of preparations of the ovary and spermary of crayfish or other animal, illustrating the cellular nature of the germ-cells. Demonstration of preparations, showing pronuclei approaching and united. *Fertilization. Preparations showing three phases of mitosis in first and second cleavages in any favorable egg (drawings). *Cell division. *Cells in development and growth of animals.

NOTE. — Fertilization and cell-division are better illustrated by preparations from animals other than the crayfish. At various times such materials as starfish, sea-urchin, barnacle and mollusk eggs have been used in this connection and found satisfactory.

In the description of cytological structures and processes the attempt is to avoid the intricacies of centrosomes, chromosomes, etc.

Examine a crayfish, lobster or prawn with eggs attached to the appendages. Examine and draw stages in the development of the crayfish or lobster.

## 5. *GENERAL PRINCIPLES OF ANIMAL PHYSIOLOGY AS ILLUSTRATED BY THE CRAYFISH[1]

Movements and the muscular work of the body. Source of the energy thus manifested. Statement of the law of conservation of energy and familiar applications. Oxidation in liberation of energy, and illustrations. Foods as sources of energy. The need of oxygen. Waste, repair and growth of the body.

The stages of nutrition and the *essential* processes involved in each — digestion, absorption, circulation, assimilation, respiration, dissimilation, excretion. Special attention is given to the idea that physiological processes are ultimately referable to the component cells of organs; and also emphasis is placed on the consideration of each process as related to the life of the body as a whole, that is, to general nutrition. Finally, the nervous system is considered as a regulating and coördinating mechanism.

Physiological division of labor in the crayfish. Illustrations of the principle as shown by specialization in human social organization. (No reference is made to lower forms of animal life until they are studied.)

*Relation of the crayfish to its environment — Ecology.

*Animals in their relation to plants in the ultimate food supply.

[1] The general trend of the discussion of topics in physiology follows that of Chapters 8, 9 and 10 in Martin's *The Human Body*, Briefer Course (Revised Edition by Fitz, 1898). In earlier editions the chapters are numbered differently, but bear the same headings: "Why We Eat and Breathe," "Nutrition," and "Foods."

Many suggestions concerning the presentation of the general principles of physiology in connection with study of lower animals were gathered from *The Crayfish as an Introduction to the Study of Zoölogy*, by Huxley, and from Wilson's account of the earthworm in Sedgwick and Wilson's *General Biology*.

### 6. Summary of the Introduction

Attention is called to the study of the crayfish as illustrating the various standpoints from which any animal may be studied, namely, external structure with homologies and adaptations, internal structure and functions, gross and minute structure, classification based upon resemblances of structures, distribution in space and time, development of the individual, relation to environmental conditions, life histories and habits — these phases of zoölogy have been illustrated by study of the crayfish. Throughout the course it is continually impressed upon the pupils that no part of the study is exhaustive, and suggestions for work beyond this course are frequently made.

*Definitions of biology, zoölogy, botany, morphology, physiology, anatomy, histology, embryology, natural history.

## *II. Studies of Animal Types*

The crayfish having served as a basis for the introduction to some of the most important aspects of animal structure, functions and relations, less extensive studies of representatives of the important groups of invertebrate animals follow, and to this work seven weeks are given. This in turn is followed by a study of common vertebrates during five weeks at the close of the half-year course.

In these studies of animal types the aim is to give acquaintance with common animals and to extend the application of the principles of morphology and physiology which are first introduced by study of the crayfish. Unless otherwise specified the laboratory study is from the standpoint of external structure, especial attention being given to those characteristics which underlie classification and adaptation to environment. It should be remarked here that, with the exception of a few instances, classification is not carried below the orders. Uses of parts are determined by experiment whenever possible, and stress is placed upon the study of habits, life histories, and ecological relations.

1. Crustaceans.

Examination of sow-bug (Oniscus), water-fleas (Daphnia and Cyclops) and barnacle (Lepas) (outline drawings).

*The crustacea, general characteristics, distribution in space and time, the principal orders, economic relations.

2. ARACHNIDS.

Examination of spider (outline drawings), and some observation of habits in the laboratory and in field. *Allies of the spider.

3. INSECTS.

*a.* "Grasshopper."

Examination of external structure (outline drawings). Study of habits. Stages in the life history (drawings and notes). Compare adults of two species.

*b.* Butterfly.

Examination of adult, caterpillar and chrysalis of the milkweed or monarch butterfly (Danais) (outline drawings, dorsal and lateral views). Observation on butterflies in the field.

*c.* Life histories of cricket, beetle, bee, ant, fly, may-fly, cicada.

Examination of adults and the larval stages (outline drawings and notes). Observations in the field. The larvæ of blow-fly, Cecropia and other moths, meal-beetle and other insects obtainable are kept under observation until metamorphosis occurs.

*Life histories of insects. Readings — Kingsley, *Comparative Zoölogy;* Needham, *Lessons in Elementary Zoölogy;* Weed, *Life Histories of American Insects;* Comstock, *Insect Life;* Davenport, *Introduction to Zoölogy.*

Collection of insects with at least two representatives of each common order; only familiar forms are identified as to genus and species.

*Protective resemblance, mimicry, parasitism, commensalism, social life and economic relations.

*Summary of the phylum Arthropoda — general characteristics as illustrated by the types studied, general classification. *The wealth of numbers of species and individuals, and the variety of form in the phylum.

4. WORMS.[1]

*a.* Earthworm.

External structure (drawings), movements and reactions of the living worm. Field observations. Examination of the general internal anatomy[2] (drawings and notes). *Life history of earthworm. *Economic importance.

*Structure of earthworm and crayfish compared.[3]

*b.* Flat worms.

Planarian (living) and tapeworm (drawings). *Life histories. *Parasitism.

*c.* Round worms.

Trichina and "horsehair-snake" (Gordius). *Life histories.

5. CŒLENTERATES.

*a.* Hydra.

General structure as illustrated by a living animal and longitudinal sections, budding, reproductive organs (drawings and notes). Movements, responses to stimuli, feeding. *Life history. *Radial symmetry.

*Physiology of Hydra compared with that of the earthworm and the crayfish.

*b.* Hydroid colony (Pennaria, Obelia, Parypha or Campanularia).

Structure of a colony and of the individual zoöids (drawings). Compare zoöid with Hydra. Formation of medusæ. General structure of hydromedusa (Gonionemus) and of a scyphomedusa (Aurelia) (drawings).

*Life history and alternation of generations.

[1] For the purpose of this outline it seems best not to use the modern subdivision of this heterogeneous group.

[2] The earthworm is not easily dissected by a beginner, and preparations are used to illustrate the internal structure. The worms are dissected in the ordinary way, and pinned on strips of cork-linoleum. These strips occupy little space in the preservation jars, and can be easily removed and placed in pans of water during examination by the pupils.

[3] Attention is called to the possibility of more extensive study of the structure and functions of the earthworm, if time permitted.

*c.* Corals.

Sea-anemone (Metridium or Sagartia). External structure and transverse sections (drawings). Skeletons of Oculina and of Astrangia with zoöids in position. *Corals — life history, distribution, formation of the skeletons, island formation. Demonstration of skeletons of important corals.

6. SPONGES.

Structure of Grantia (drawings). Fresh-water sponges (Spongilla). Commercial sponges. Glass sponges. *Life history, and formation of the skeletons.

7. PROTOZOA.

Paramœcium or Spirostomum studied in the laboratory. *Unicellular nature of Protozoa, protoplasm, nucleus, cell-activity, cilia, reproduction by division, intra-cellular digestion. (As far as possible these topics are studied by the laboratory method.) Various forms of Protozoa are demonstrated in order that the pupils may gain some idea of the variety of unicellular animal life.

*Physiological processes in unicellular animal compared with Hydra, earthworm and crayfish. *Physiological division of labor as illustrated by this series of animals.

*Review of the general characteristics of Protozoa, Cœlenterata, "worms" and Arthropoda in this order, which is the reverse of that followed in the original study.

8. ECHINODERMS.

*a.* Starfish.

External structure (drawings). Examination of animal with aboral part of skeleton removed, and demonstration of principal organs. *Functions of the organs. *Economic relations.

*b.* Sea-urchin (Arbacia), crinoid and sea-cucumber (Thyone).

These are examined for the characteristics which show their relationship to starfish, and are demonstrated in connection with lectures on characteristics of the phylum.

9. MOLLUSKS.

*a.* Gasteropods.

The Snails.[1]

Study of living animal, external structure (drawing from right side).

Observation of habits of living animal — movements, feeding, reaction to stimuli.

Examination of entire shell and longitudinal section. Compare size, color and markings of several shells: Structure — apex, aperture, umbilicus, lines of growth, columella, direction of twist (drawings). Structure of shell — three layers. Test with acid.

Animal removed from shell. Location of the organs which are visible without dissection (drawings as seen from right and left sides).

Examine shells of various marine gasteropods and compare.

Become acquainted with our native snails of genera Helix, Physa, Limnæa, Planorbis.

Examine set of Helix nemorosa showing individual color variation. *Individual variation.

Slug (Limax).

Examine living slug, and compare with snail. Observe movements and habits. Draw as seen from right side.

*b.* Lamellibranchs.

Mussels and clams.

Examine shell, right and left valves, inside and outside (drawings of right valve). Animal with right valve removed — location of superficial organs without dissection (drawing).

Living clams in aquaria. Currents indicated by powdered carmine (diagrams showing direction of currents). Locomotion. Feeding.

Oyster.

Examine several shells and compare forms. Locate structures mentioned for clam-shell. Compare right

[1] The European edible snail (Helix pomatia) is used because readily obtainable in New York markets.

and left valves (draw right valve, inside and outside views).

Demonstration of currents in living oyster. Microscopic examination of moving cilia on oyster gill. Cause of currents?

Examine oyster with right valve removed. Locate principal organs without dissection (drawing).

Examine young oysters ("spat").

Examine shells of other bivalves, comparing all points with shell of clam.

*c.* Cephalopods.

Squid.

External structure (drawing). Nautilus, examine alcoholic specimen and shell sectioned to show chambers.

10. VERTEBRATES. (*Five weeks.*)

*a.* The amphibians.

The frog.

Chief external characters (outline drawings from dorsal and lateral views).

Observation on the living frog. Movements, breathing, feeding, responses to stimuli.

Internal structure[1] — general structure of digestive, circulatory, respiratory, excretory, reproductive and nervous systems (diagrams of systems of organs).

Histology. Blood, muscle, epithelium of skin and intestine, liver, ciliated cells, cartilage and bone.

(Fresh material is used for most of this work and is supplemented by prepared slides.)

*Review of the cell-theory.

Development of the amphibian egg — laboratory study and lecture.[2]

*Oviparous and viviparous development — advantages and relative numbers of young individuals.

[1] Dissections in part by the pupils. Preparations by the instructor are kept at hand for reference and demonstration.

[2] This work comes at a season when developing eggs cannot be obtained, and material preserved in formalin is used. Later, when developing eggs are obtainable, outlines for observation at home are given to the pupils.

Examination of the external characteristics and habits of the urodele amphibians (salamander, newt, mud-puppy).

*The Amphibia — characteristics of the principal orders, and demonstration of the general characteristics having systematic value.

*General physiology. Principles of physiology first considered in connection with the crayfish are reviewed and with some expansion are applied to the frog considered as a type vertebrate.

The frog is used to illustrate the general biological features of the vertebrates. A general survey of the other vertebrate classes, designed to give general acquaintance with the important forms, follows the study of the frog.

*b.* The fishes.

Examination of a teleost and dog-fish for general external characteristics (outline drawings). Observation of living fishes — movements, habits, food, respiration, etc.

*Development, illustrated by a series of trout embryos. *Artificial propagation.

*The principal orders of fishes, and demonstration of their characteristics. *General characteristics of the class. *Economic value. *Geographical distribution.

*c.* The reptiles.

Important orders and their characteristics, as illustrated by demonstrations of lizard, snake, alligator and turtle.

*General characteristics of the class. *Geographical distribution. *Useful members of the class.

*General aspects of the embryonic development — demonstrations of embryos.

*d.* The birds.

*Important orders and their chief characteristics. Useful birds. *Suggestions for field study.

Demonstrations — series of chick embryos. *General sketch of the development.

*e.* The mammals.

Principal orders[1] — their characteristics and familiar representatives.

*Examination of skeletons of frog, turtle, bird, cat, monkey and man. Special attention is directed to the homologies of the limbs (outline drawings).

*Homologies among vertebrates. *Analogies. (Illustrated by preparations and lantern slides).

*Review of the distinguishing features of the five classes of vertebrates. *Evidences of relationships (demonstration).

*Characteristics of the phylum Chordata. *Primitive Chordates.

*Fossil vertebrates and their relation to living types (demonstrations at museums).

*Review of the general classification of animals. Practical tests of pupils' ability to recognize representatives of important groups.

*The evidences of common descent of animals — evolution.

Application of the general principles of morphology and physiology, which the course has introduced, to the structures and activities of the human body.

*The zoölogical position of man in the light of structure.

NOTE. — The pupils in this year's class have had the usual "elementary physiology," and gave evidence of readily grasping the above comparisons. In previous practice, when more time was assigned, it has been found profitable to lead into consideration of the functions of the human body from a more advanced view-point than is possible in the usual elementary course. This study of the human body and its functions from the comparative view-point is, in the opinion of the writer, the most important application of the general principles of zoölogy.

### *Extension of the Course from Half-year to Full-year*

It is evident that in a half-year's course many of the topics mentioned in the outline must be given rather hasty consideration.

[1] It is proposed to make next year's work on birds and mammals more practical by examining representatives of the orders at the American Museum of Natural History and at the Zoölogical Gardens.

In case it becomes advisable to extend the course throughout the year, giving double the time, no great modification of the outline need be made. In addition to more stress upon the study of the human body, as suggested in the above paragraph, many of the topics may with profit receive more time, each type of animal may be studied less hastily, and more allied forms may be examined for the sake of a wider acquaintance with animals and animal life.

## Appendix A

### *The Crayfish as an Introductory Type*

The crayfish has been chosen after consideration of mammal, frog, fish, crayfish, grasshopper and earthworm. After starting various groups of pupils with four of these forms, the writer has come to believe that the crayfish has some decided advantages as a form with which to begin the practical study of animals.

First, pupils have less aversion to handling the crayfish than in the case of any of the other forms, except the insect. Teachers will recognize that this is an important point, for the first impression largely influences the pupil's attitude toward a subject. An objection to the insects is that they are highly specialized and do not so well illustrate general principles, and the small size makes it impossible for beginners to study the internal anatomy. On the other hand the crayfish is easier to dissect than any of the other forms, and the general structure is easily understood by even very young pupils. The internal organs are comparatively simple, and yet there is such physiological division of labor that definite organs have particular functions. The complexity is not so great as in the case of a vertebrate, and it is easier for the pupil to gain a clear idea of functions of organs as related to the life of the body as a whole.

The external structure is very favorable for teaching principles of homology and classification at the same time that habits of scientific observing are being developed. So far as observation of a living animal is concerned, it is hardly possible to begin with a more favorable form.

Finally, there is a great advantage in that the animal can be readily obtained in most places outside of New England, and is found in the markets of the cities.

## Appendix B

### *Methods of Conducting the Course*

The course is introduced by laboratory study which is made the basis for supplementary reading, lectures and recitations. This plan is followed throughout the entire course, and no animal is extensively considered until the pupils have had some personal acquaintance with the form; and no structure is described which is not illustrated by the pupils' laboratory studies or by demonstrations given by the instructor. It is believed that there are enough important things which the pupils can see for themselves, and as a rule it is quite unnecessary and undesirable to discuss animals or parts of animals with which the pupils do not have a personal acquaintance.

A brief statement will make clear the minor methods of conducting the work. The various points included in the outline for laboratory work are presented to the pupils in the form of mimeographed directions which set problems for the pupils to solve. A special attempt is made to guard against the common error of giving problems which are quite impossible for a beginner — such are better demonstrated by the teacher or omitted altogether. There are enough important problems which the pupils with some direction can solve with certainty. Experience has shown that the direction for working out a problem can in the beginning scarcely be too complete. Brief outlines for laboratory study are worse than meaningless to the young beginner. In order to get the best training every step of the way should be clearly pointed out. If classes are small it is better for the teacher to give much of the direction verbally, but with large classes the printed directions may give the pupils much valuable help, which the teacher cannot possibly find time for giving.

Especially with regard to problems too difficult for a beginner is it necessary to be careful in the study of living animals. The results to be obtained from many experiments suggested by authors are of very doubtful value, since science yet awaits an interpretation.

With regard to the supplementary work in lecture and recitation it has so far been necessary to dictate notes on subjects which require explanation and supplementation, but these notes are being expanded into text-book form and in mimeographed

sheets will hereafter be put into the hands of the pupils. For supplementary information in the line of natural history references have been given to certain chapters in elementary books.[1]

The laboratory records are kept by means of both outline drawings and notes. The pupils are required to express in writing some results which cannot be illustrated by labelled drawings. The common tendency to create in the mind of pupils the impression that the making of a note-book is the chief end of laboratory work is believed to be the result of undue emphasis which many teachers place upon notes. It is held that there are many results of observation which are better recorded in the memory, and practice along this line is frequently given, the pupils being tested by verbal questioning. A teacher can judge pupils by their attitude when at work far better than by note-books alone. Note-books should be kept for the sake of the training, which the preparation gives, and as a record for persons who have not seen the actual working of the pupil.

## The Course in Botany

By FRANCIS E. LLOYD

### A. INTRODUCTION

There are, at the present time, two main schools among teachers of botany, representing a difference of opinion chiefly as regards the way of approaching the study with a class of elementary students. This difference has already been alluded to in the closing paragraph of the preface. To restate it briefly, the one school attacks the study at the lower end of the scale of life, advancing from the simple to the complex. The other begins at some convenient point which involves the minimum amount of technical difficulties and of strangeness, and is content to sacrifice the appearance of logic for a way which offers less friction. Setting aside this divergence, there appears to be a fairly

[1] After this outline was completed, the writer had an opportunity of reading the new *Introduction to Zoölogy*, by Davenport. It was noticed that in general the book well covers the ground with respect to the natural history studies which during the past year were included in the Horace Mann School course in elementary zoölogy, and it will be useful as supplementary reading in connection with very many topics.

general understanding as to the amount and kind of matter to be presented. Courses differ, to be sure, in details, but these may be accounted for by local conditions, as for example the experience and abilities of instructors, the time allowed and the maturity of the students. This general agreement lies in the demand that the student have opportunity to acquaint himself with the essentials of plant structure, physiology and ecology. Furthermore, it asks that this knowledge shall not be confined to one group of plants, such as the Spermatophyta, but that the student should gain a knowledge of the more readily observable facts about the lower forms as well. It is also generally insisted on that a physiological view-point should be had.

Between such courses as carry out more or less fully these ideas and the one now before the reader, there is a certain amount of parallelism. But in the method of attack this outline in particular agrees more especially with such courses as are to be found outlined in Spalding's *Introduction to Botany* and Bergen's *Botany*. The writer desires to acknowledge the former especially as a source to which he is indebted for valuable suggestion for a number of years, and especially at the beginning of his teaching experience.

It is, however, believed that in the course as here worked out there are several points of difference which may be mentioned. One of these lies in the emphasis placed upon the study, first of all, of the fruit rather than the seed. The method of beginning with the seed the writer followed for a number of years, until it was found deficient in the treatment of difficulties growing out of a study of the 'grain' of Indian corn, a study which we rightly persist in, but which has taxed and still taxes the understanding of very many students and not a small number of teachers of botany. The difficulties referred to are those arising out of the persistent indehiscent pericarp which closely invests the seed. The latter, during its growth, loses its integuments by absorption, and it has been shown that the inner layer of the pericarp suffers the same fate.

In addition, the morphological questions involved in a study of the grass embryo have been the subject of wide discussion, and indeed can hardly be said to have been answered as yet. By virtue of this wide departure from the usual, the Indian corn has been a classical object of research, while in spite of these it

has, on account of its size, been made the basis for instruction. In addition to its intrinsic value as material for teaching, on the grounds above stated, it is of more than usual value to American teachers and students because of its economic importance.

By instituting then a comparison of the obvious morphological features of the fruit of several forms, and by the selection of proper materials on which to base this comparison, it has been found possible to obviate the difficulties mentioned, and to lead the student to a correct understanding of the fruits studied. More specifically, the task set for the student is to identify the parts of the leguminous fruit, drawing attention to the internal relations. By the use of corn taken before and during anthesis, and of ripe sweet corn, the homologous parts are readily identified, and the student is thus forced to the conclusion, otherwise difficult to form, that we are dealing here with a fruit, the pedicel of which is short and thick, and the locule of which is completely filled by the seed. This conviction is strengthened by the examination of a grain of 'rice' pop-corn, in which the pericarp is somewhat inflated, or at any rate not completely filled, at the base of the style, by the seed.

It has also been found to be of no little value to ask the student to compare the old and young condition of the fruit in each case, with the object of leading him to the idea of development rather than to a statical conception of the matter in hand. The importance of this can hardly be over-emphasized, for the tendency of botanical teaching in the past, now happily growing less marked, has been to view plants from the latter point of view, one which can do little else than to lead to a one-sided and so distorted idea of plant life. The reaction against this method has been seen in the publication of several text-books, unquestionably of merit in themselves, but which seem to represent once again a too radical change in the theory of teaching, though possibly less actual change in practice.

It will be found on perusing this outline that the amount of detail given varies materially in different parts. This is done for the reason that it has been deemed unnecessary to state more than briefly those subjects which may be found sufficiently treated in the numerous text-books and laboratory guides in prevalent use. Those parts, however, which are to be met with less

frequently or not at all, have received a more detailed treatment according as the case has demanded.

Attention may be called more particularly to the method of treatment of foods in plants, and of digestion and absorption, a method which has been adopted from those of the physiological chemist and which has been found admirable in practice for its applicability to elementary teaching in spite of technical difficulties always confronting one who is making an exact study in this difficult field of inquiry. This method has an additional advantage in rendering entirely unnecessary any microscopical examination of food,[1] involving as it does micro-chemical reactions, which, however valuable they may be for the advanced student, are certainly too difficult for the beginner, especially in the high school. In particular it has been the object of the writer to bring clearly before the student the problem of digestion, a subject which has given no end of trouble and which is often veiled in misconception. The essential similarity of plants and animals in this regard is in this way brought into prominence. In this connection the writer desires to bring to the attention of teachers the great value of the cocoanut and of the date as material for demonstrating the morphological facts involved. The necessity of absorption is brought out by these much more strikingly than in the case of smaller forms. To be sure, there is the difficulty of obtaining material, not in the first instance, but of developing seedlings. In the date, however, this is extremely easy (see footnote on p. 44), but in the cocoanut less so. Let it be said, however, that any trouble and patience necessary in getting good specimens is more than justified by the results which accrue. The exceedingly beautiful, large haustorium (the cotyledon) and its relation to the endosperm, can be demonstrated to a large audience with the effect above noted of bringing clearly to the mind the conditions which make digestion necessary.

That part of the outline dealing with types of plants will not be found to carry one far off the beaten track. It will be observed, however, that the ecological point of view is maintained throughout, for it is contended that the small amount of work which the curriculum permits is not sufficient to lead the student

[1] The examination of starch, and its color reaction to iodine, is observed microscopically on account of its ease.

to any but a very imperfect conception of the relationships of plants. A course, however, which failed to bring out clearly the fact that such relationships exist would strike very wide of the mark. The writer has had occasion to examine a considerable number of students who have been subjected to courses which purport to attain this end, and he has failed to find one such student who was able to show signs of knowledge of this kind. It is the point of view which is here aimed at; it is not the ability to give the term descriptive of the shape of a leaf, but rather to ask an intelligent question about the part which that leaf may play in the economy of the plant, and how that end is the better attained as a result of the form and structure of that leaf. To repeat, it is the dynamic and not the static conception that has been given prominence.

It is becoming the custom to add to the ordinary elementary course, as outlined in certain recent text-books, a section dealing with the ecology of plants. One might almost assume that here was a new and sudden development in the teaching of botany. It is, however, the outcome of a commendable movement which may be traced back a number of years. The plan, however, of making the topic something almost apart from the general subject is to be deprecated. Thus, even in appearance, to divorce ecology from the rest of the science is not in accord with the modern conception of a 'synthetic' rather than of an 'analytic' method of treatment. Morphology has no meaning apart from physiology, and a synthetic treatment of these leads to ecology.

Again, much less strain has been laid upon a study of sexual reproduction in the narrower sense than upon a study of the vegetative body and the more readily observable phenomena of adaptation. Some knowledge of the evolution of the shoot and root as exemplified in the gametophyte and in the sporophyte is considered of more value than a more exact knowledge of homologies, a subject which taxes the understanding even of mature students.

It must not be supposed, however, that the matter of sexual reproduction is neglected. It will be readily understood that a subject which is so special and difficult can hardly be regarded as fit for high-school students. And yet it is a subject, the essentials of which may be very clearly brought out in a study of such forms as Spirogyra and Vaucheria. The attempt is

seriously made to show that the fact of sexual reproduction exists also for other forms, without entering far into morphological details. In taking up the seed plants in this connection, somewhat more attention is paid to details, and the important morphological facts involved are demonstrated by means of charts and preparations. At this time also is demonstrated the phanerogamic embryo in earlier and later stages of development, and so the study of the life cycle, which was commenced by the study of the fruit, is rounded out to completion.

There is a further point of importance in that the very natural and essential facts about the subject of sexual reproduction may be made a part of the knowledge of young students. Such knowledge, it is believed, helps to lift the mind to a normal conception of a question which is in the young mind very frequently befogged and distorted to the pronounced detriment of the moral nature.

It may also be worth while to point out a few practical considerations which make the carrying out of this course feasible. Some exception may be taken to the amount of time and work necessary to cover the ground indicated, for when the amount of time actually given to this study is summed up, it is after all but little. The objection, if such is raised, will be removed when it is understood that a detailed study of everything is not required, nor is it expected that everything that is studied, or in any way examined, shall be drawn. With reference to the first point, it must be further explained that an effort is made to give the student an opportunity to see a good many forms, so as to enrich the field of observation. To this end, when the opportunity offers, excursions are taken to glass houses, museums and the field. Here again it must be said that only a few such excursions may be planned, and these are of necessity brief, on account of unfavorable local conditions. As to the drawings in the laboratory note-book, when such are demanded, only the simplest outlines are required. Any attempt at more elaboration is usually suppressed, as the amount of time at the disposal of the class is too limited to allow it.

Quite a number of matters are to be found also in the outline which are not done by the student, but which are, however, in some way or other brought to the pupil's notice. This is done by means of demonstrations. The practice of devoting a whole period to the study of preparations and diagrams of special in-

terest has been found profitable for young as well as for more mature students.

In carrying on the work in the laboratory, the student is given detailed outlines prepared for his guidance during each exercise. These are planned to lead him to make careful observations. It has, however, been the aim to make it necessary for the student to do some real thinking for himself, and to this end the detailed outlines are put partly in the form of questions. It is very easy to swamp a beginner with questions, and this should be avoided. At the same time the obsolescent method of verification is deemed insufficient for educational purposes.

In addition to the outlines for the laboratory work of each day, a number of questions are formulated from time to time covering given parts of the work. These questions have been found useful in helping the student to focus the attention on the more essential points, and are in a sense a measure of his success in the study. Additional tests are given in the form of brief essays on very definite topics, such as a particular experiment. A fair amount of thoroughness in such work is taken as a basis for standing, in lieu of the examination.

The use of a text-book is required for the reason that the contents of the note-book are, even under the best of circumstances, too incomplete to warrant entire dependence upon it. The text-book is for reference and must be used in connection with and after the work which is done in the laboratory.

Reading in addition to that in the text-book is occasionally required. The plan of assigning a piece of reading to a particular student who is expected to give for the benefit of the class a clear and concise account of his study of the reference has been found to bear good results. For this purpose some of the shorter publications of the government and of state agricultural experiment stations have been found good. In such ways as this the students are brought to appreciate the work of the government and the value of it economically considered.

Other sources for reference are found in text-books of various authors, and in other writings of a less special kind, such as Geddes' *Chapters in Modern Botany;* Kerner-Oliver's *Natural History of Plants,* and the like.

B. OUTLINE OF THE COURSE

## *I. The Structure and Physiology of Plants*

1. THE LIMA BEAN: The fruit and seed.

*a.* The fruit:

External features of the pistil and of mature fruit compared: pedicel, ovary, style; the relative rapidity of development of these parts.

Lateral view, one valve removed, with seeds in position: the funicle, strophiole[1] and micropyle.

Transverse section of the fruit taken through the funicle of one of the seeds: valves of the legume, oblique striation of valves, and the sutures, the seed coat, cotyledon, and the lateral insertion of the funicle on the pod. Dissemination.

*b.* The seed:

Fresh and dried seeds compared:

External characters: hilum, chalaza, micropyle and strophiole.[1]

The embryo: hypocotyl,[2] plumule, cotyledons, the vascular tissue and root cap as seen in longitudinal section.

2. THE INDIAN CORN.[3]

*a.* The fruit:

The 'grain' and a pistil[4] taken during anthesis compared each with the other and with the bean fruit: pedicel, ovary and style; the base of the withered

[1] This structure is not considered important as far as the student is concerned, but as it is often noticed and inquired about, it is deemed worth while merely to mention it.

[2] Not a little confusion exists in the terminology of the stem of the embryo. The term hypocotyl is here used as applying to the *whole* of the axis below the cotyledons. The radicle is therefore the lower end of the hypocotyl. The root is thus regarded as originating in the stem.

[3] This type is taken next because the transition is simpler than to the castor oil.

[4] The material is collected during anthesis the previous season and preserved in 5% formalin. Each student may then see an ear of corn at this interesting period of its growth. Ripe ears are also used. A chart showing a diagram of a longitudinal section of the perfect pistil is shown.

style in the mature grain of sweet corn and rice pop-corn.[1]

*b.* The external features of the embryo in longitudinal and in transverse section; the endosperm.

3. THE CASTOR OIL PLANT.

*a.* The fruit:

External features in young and old specimens compared. Comparison also with the fruit of the bean. The striations on the endocarp showing after the exfoliation of the exocarp. Compare with striations of the bean pod. Dissemination in both compared.

*b.* The seed:

External features in young and old specimens: hilum, raphe, chalaza, caruncle, micropyle.[2]

Internal features; the endosperm; the embryo and its parts.[3] Relative position of radicle and micropyle.

4. THE PINE.

External features of the young ovule-bearing scale and the subtending scale or bract.[4] The ovules and the young wings.

Old scale with mature seeds and wings. The manner of attachment of the wing to the seed.

Structure of a seed[5]: integument, micropyle, endo-

[1] Rice pop-corn is useful for comparison on account of the empty space at the base of the style.

[2] The difficulty experienced in finding the micropyle makes it profitable to have a chart showing a longitudinal section of the seed. A similar section of a young seed (ovule) is also shown for purposes of comparison, and as an illustration of the value of developmental study. The same chart shows also the chalazal pore and entrance of vascular tissue, the significance of which is seen more fully later on. Longitudinal sections are demonstrated. It is to be noticed that the testa in this seed is a part of the *inner* integument. This is incorrectly stated in some texts.

[3] Seeds should be well soaked (48 hours) to insure successful dissection, otherwise the cotyledons will break and stick to the endosperm.

[4] Suitable material is collected, preferably in the spring, from firs or spruces. Young pine cones are not so good, but serve the purpose.

[5] The seeds of a western pine (*Pinus Coulteri* or *P. sabiniana*) are very good. They must be soaked well (for a week or more), and can then be split open longitudinally without damaging the endosperm or embryo. Such materials must be obtained from seedsmen.

sperm, embryo: cotyledons, hypocotyl, radicle and root-cap.

At the close of the foregoing study a short time is spent in examining a small collection of fruits and seeds, illustrating a number of different methods of dissemination. Especial attention is drawn to

(1) The correlation between the number of seeds produced in a locule and the method of dissemination, and

(2) The analogies existing between the seed coats of some seeds and the pericarp of indehiscent fruits.

5. STUDIES IN GERMINATION.[1] — The four types mentioned above, together with others, are used for the study of germination.

*a.* Absorption of water; localization of

*b.* The rupture of the seed coats (and pericarp in certain forms).

The exact manner of rupture.

The cause of rupture.

Special adaptations:

The 'peg' or 'heel' (e.g. squash).

The stem-pad (e.g. corn).

The lid and radicle of certain monocotyledons (e.g. Tradescantia, date).

Growth of endosperm (e.g. Ricinus).[2]

*c.* The precise manner in which seedlings break through the ground: behavior of the epicotyl (pea), hypocotyl (castor oil) and cotyledon (onion).

*d.* The development of the organs found in the embryo:

Direction of growth.

Amount and relative rapidity of growth of various organs. Determination by experiment of the zone of growth in the root. Movement of the zone of root hairs.

Irritability of root and shoot: geotropism, phototropism, hydrotropism, traumatropism, thigmotropism.

[1] It is well to soak seeds thoroughly in order to secure prompt germination.

[2] The castor oil seed germinates well — albeit a little slowly — and is a very beautiful type for these observations. Seed may be purchased at small cost from seedsmen. The variety "Zanzibarensis" has the largest seeds, which are therefore the best for laboratory work.

*e.* The behavior of the cotyledons during germination:
As food-storage organs mainly or wholly.
As storage organs partly, and later as foliage leaves (e.g. squash, onion).
As food-absorbing organs (e.g. corn, cocoanut, date).

*f.* Form of the earlier leaves compared with the adult form.

*g.* The production of other shoots (in the pea) after the destruction of the plumule.

*h.* Etiolation. The behaviour of growing seedlings in darkness. Seedlings which are grown in darkness,[1] and planted deeply in the soil, are compared as to *form* and *color*. The ecological significance of their behavior.[2]

6. RESPIRATION.

It is found advantageous during the study of germination to demonstrate the necessity of oxygen for growth. This is done by attempting to grow seeds[3]

[1] Small (2-3 inch) pots, which cost but little, are very useful for such work. A completely dark chamber can be made of metal (tin or galvanized iron) in the form of a can without the lid. Large coffee cans can be used for the purpose. Cover the pot with the can, the whole standing on a bed of sand.

Not only seeds but other plant structures (tubers, bulbs, corms, e.g. Indian turnip) might be experimented upon by the teacher, and the results reported to the class. It cannot be too much appreciated that a teacher's power and influence is increased very greatly if he is doing more work of this kind than a class can do, for lack of time or other reasons.

After the specimens are grown, especially if striking results are attained, a set of three seedlings, one a control, showing the different behavior, may be fastened on a slip of glass with gelatine, labelled and preserved in 5% formaline. The sheets of glass can be cut so as to be placed in cheap preserving jars, or specimens may be sealed up in glass tubing. For valuable suggestions see Stone, G. E., "Formaline as a Preservative for Botanical Specimens," *Journal of Applied Microscopy*, Vol. 2, No. 10, p. 537.

[2] The lengthening of stems must be regarded as an adaptive feature, and not as an abnormal or pathological condition. The following literature in the study of etiolation may be mentioned as valuable for reference. MacDougal, D. T., "Light and Vegetation," *Popular Science Monthly*, 54: 193-201, December, 1898.

[3] Oats, in which there is but little intramolecular respiration, are used. The experiment as recommended by Ganong (*Botanical Gazette*, Vol. 27, p. 255, 1899) has been found very satisfactory.

in an atmosphere devoid of that gas. A control experiment must of course be set up.

Respiration involves chemical change. The latter results in the evolution of heat. That chemical changes are taking place in germinating seeds may be shown by means of two accurately paired thermometers (one for a control experiment), as indicated by Detmer.[1] Seeds killed with formaline are used in the control.

7. NUTRITION (FOODS). — The kinds of foods, and methods of determining their occurrence, especially in seeds.

Some phases of the physiology of nutrition are studied in connection with the work outlined in the preceding pages. The subject is taken up here in the following manner.

*a.* Proteids.

Demonstration of the reactions of an acknowledged proteid by applying the following tests to a weak solution of egg albumin in water:

Coagulation by heat. Test the coagulum with nitric acid and ammonia. Boil a little of the albumin in nitric acid, *cool* and add *slowly* ammonia.

Determine whether proteids occur in the seeds which have been studied, or other seeds.

Grind up as finely as possible in a coffee mill about 25 grams of dry seeds. Make extracts as follows:

(1) With water (100 cc.), allowing to stand for 24 hours. Test the extract obtained with the above tests, and compare the results with those obtained above with egg-albumin. Note the similarity of animal and plant albumin.

(2) Taking the same material, extract it with a 10% solution of common salt. A second proteid, insoluble in pure water, will thus be obtained. Obtain this in dry form by dialysing and drying. This may then be examined and tested as above.

(3) A third proteid may be obtained from wheat

[1] Translation by Moore, p. 28.

by taking the flour, making a dough, and then washing[1] the dough in a cloth under the tap. The sticky substance, gluten, is a proteid which is insoluble in water, and should be tested with nitric acid and ammonia.

(4) Does gluten occur in peas? The question should be answered by applying the method in (3).

The above work is done by the instructor for the class. The students repeat the nitric acid-ammonia test on the solid food-storage parts of the seeds they have studied. After boiling the substance a moment in nitric acid in a test tube, pour off the acid and add a drop or two of ammonia. Millon's reagent for proteids may be substituted, but it must be fresh and obtained from the makers. The food-storage parts must be heated in a little of the reagent.

*b.* Starch.

Demonstrate the color reaction of starch with iodine by adding the latter (a very weak solution) to some *very thin* starch paste.

Examination of starch grains in the cells of the potato tuber,[2] mounting the section in very weak iodine solution,[3] drawing of one or two cells with contained starch grains.

Application by the students of the iodine test to determine the presence or absence of starch in the seeds studied.

*c.* Sugar.

Determine the color reaction of Fehling's solution and grape-sugar or glucose[4] by boiling them together and obtaining a red precipitate.

[1] By saving the washings, chiefly composed of starch, a rough estimate of the relative amounts of starch and proteid may be obtained. The water-soluble proteids are of course partly or wholly lost, according to the thoroughness of the operation. Recall the value of wheat as a staple.

[2] If a rather thick section of the tuber is first well rinsed in water, the starch will be washed out of the broken cells so that the cells left intact are more or less isolated.

[3] Made by adding crystals of iodine to a weak solution of potassium iodide in water.

[4] Ordinary sugar of commerce may be used, but must be remembered to contain cane sugar for the most part, which does not react to the Fehling's solution. The test thus made is therefore not very satisfactory,

Tests are applied to the seeds studied by the student for the determination of the presence of sugar.[1]

*d.* Cellulose (reserve cellulose). It is pointed out that this food substance does not occur in any of the seeds heretofore studied.

Demonstration of the hard white reserve cellulose as it occurs in the date or persimmon seed.

Using a well soaked seed, make a thin section with a sharp knife, place the section on a piece of glass in chlor-zinc-iodine.[2]

*e.* Oils.

Demonstrate the solubility of an oil (e.g. cottonseed or olive oil) in ether.[3]

Grind up some of each kind of the seeds studied, and extract them with ether. Place the extracts in glass vessels, and examine after the ether has passed off.

*f.* Mineral substances.

Burn off the other substances present in the seeds studied. The mineral substances present will thus be demonstrated. It should be pointed out that a large percentage of the materials so isolated is probably of use to the germinating seedlings. A subsequent experiment will demonstrate the importance of mineral nutrients.

After the above work has been concluded the results are brought together in tabulated form. The interchangeability of certain foods is also discussed.

8. The Digestion and Absorption of Foods.

From previous considerations, food is seen to be a source of energy. This is demonstrated by planting

as only small amounts of other sugars occur. The cane sugar may, however, be inverted by adding a little dilute sulphuric acid, and allowing it to stand. A reducing sugar will be formed.

[1] When negative results are obtained it is well to test other parts of plants (grapes, buds, etc.) in order to obtain positive ones. The value of a negative result must, however, not be overlooked.

[2] This reagent would better be obtained of dealers, as it is difficult to make good.

[3] Naphtha or benzine may be used, but do not pass off as readily.

peas and corn embryos from which the store of food has been removed.

Examination of a series of seedlings of the date.[1]

Study of the structure of the seedling which has been freed from the endosperm, noting especially the enlarged end of the cotyledon which serves as a sucking organ or haustorium; note also the absence of any visible openings through which food particles might pass. Recall the conditions in the corn and compare. The analogy between this condition in the date seedling and the apparatus used in an osmose experiment. Demonstration of diffusibility of some substances, and non-diffusibility of others.

Note the insolubility of cellulose, and also

The zone of disorganized cellulose about the haustorium.[2]

It is evident, in order that food may pass from the endosperm to the embryo, it must be in the condition of solution.

Make some very thin starch paste, boiling well. A very little of this starch is in solution. Test for sugar: Place in a dialysing bag and attempt to dialyse. Testing the water outside the bag for starch and sugar yields negative results.

From this experiment it is further evident that foods must be something more than soluble in order that they may be available for the growing seedling; i.e. they must be *diffusible* as well as soluble. In view of the insolubility or indiffusibility (or both) of most foods, e.g. proteids, starch, cellulose, cane sugar, it remains to be shown that these substances (or rather, one of them to serve as an example) may be rendered both soluble and diffusible.

Take some thin starch paste, add some saliva, place in a dialysing bag[3] and dialyse. Test the starch paste

[1] After two weeks' soaking date seeds will germinate in moist sawdust in six weeks or two months; a shorter time would probably suffice under favorable conditions.

[2] This can best be done by means of a specimen cut transversely and by means of diagrams bringing out clearly the condition found.

[3] Such a bag may be made of sausage skin, well cleansed and freed from oil.

and the fluid outside of the bag for sugar. Compare with experiment above. The positive results show clearly that starch may be rendered soluble and diffusible, i.e. may be digested.

Repeat the experiment, but using diastase[1] instead of saliva. Comparison of the essential facts of the process in animals and plants.

Review of the study of the cell with especial reference to the cell wall and the condition which foods must be in in order that they may be translocated from one part of a plant to the other.

9. The Structure and Functions of Roots.

*a.* Examination of a root system of the ordinary type.

Tap root.

Structure of the transverse section: epidermis, broad cortex, stele.

Root hairs.[2]

(1) origin and shape;

(2) cytoplasm and nucleus; the phenomenon of plasmolysis, and the staining reaction of dead and living protoplasm;

(3) the attachment of soil particles to root hairs.

The root cap: its structure and use. The secretion of acid by roots.

Secondary roots: their endogenous origin, their arrangement in orthostichies correlated with arrangement of tissues in the tap root.

Adventitious roots, their deep origin, well shown by means of sections taken transversely through the first node of young corn seedlings.

*b.* Absorption of water and of mineral substances in solution by roots.

Wilting after removal of soil from the roots.

Wilting after watering with a solution of potassium nitrate (referred to plasmolysis of root hairs).

[1] May be obtained at trifling cost from dealers in chemicals.

[2] May be obtained in great abundance and in the best condition for study by placing sprigs of Tradescantia in water. Numerous adventitious roots will then start from the nodes.

Demonstration of loss of water by a plant:
By collecting the vapor transpired, by condensation;
By measuring the loss of weight in a water culture or potted plant.
Osmose. Work done in raising a column of water.
Root pressure experiment.
The path of water (and dissolved salts) in the root: (1) through the cortex; (2) through the vessels. Recall the work in connection with digestion (p. 43).

*c.* The mechanical fixation of the plant by means of roots.
In the soil: ordinary fibrous roots; "guy-roots," e.g. corn.
In climbing plants as organs of attachment, e.g. English ivy, poison ivy.

*d.* The modification of roots correlated with the storage of foods.
Primary roots, e.g. turnip, carrot, etc.
Other roots, e.g. sweet potato.
Tests for various foods found in such structures.
Vegetative reproduction by means of roots.

*e.* Modification of roots correlated with the parasitic habit.
Haustoral roots[1] of Cuscuta, by means of living cultures and preparations.

*f.* Mycorhizal roots; root tubercles.
Nature of the association: symbiosis.
Economic importance: e.g. the cowpea in the southern United States.

*g.* Air roots.
Conditions in the tropical regions.
General structure of air roots, especially the velamen.

*h.* Modifications of roots correlated with respiration.
Cypress "knees."
Respiratory roots of many swamp plants; e.g. Avicennia.

*i.* Contractile roots. Their ecology.

[1] The doubtful morphological value of the haustoria of Cuscuta may be mentioned. But the subject is too difficult a one for beginners.

10. THE STRUCTURE AND FUNCTIONS OF THE SHOOT.

*a.* The stem.[1]

External features of the stem.

Node, internode.

Positions of leaves as indicated by leaf-scars. The scars of the bud-scales and the limits of annual growths in twigs as indicated by these.

The method of branching as indicated by the relative positions of buds and leaf-scars. Recall experiment in which axillary buds are induced to grow after excision of the plumule (see p. 40).

The inflorescence as a system of branches.

(1) The flower regarded as a shoot.

(2) The raceme and its modifications: spike, head.

(3) The panicle.

The habits of trees, so far as determined by the relative rapidity of growth of different shoots. Compare with inflorescence.

Lenticels.

The growth of lenticels.[2]

Communication of interior tissues with the outside through the lenticels demonstrated by displacement of air.[3]

Internal structure of the stem.

Medulla, central cylinder, cortex and epidermis.

Phloem, xylem, cambium, medullary rays.

Secondary changes.

Exfoliation of the epidermis; formation of bark. Secondary phloem and xylem. Annual rings. Cor-

[1] For the general characters of the stem, bean, horse-chestnut, ash, or maple, willow, poplar, and beech are used very profitably.

[2] The development of the lenticels may be very beautifully exemplified by placing short twigs (I have used those of Catalpa with marked results) in a bottle with a little water in the bottom and loosely stoppered, so as to keep the air moist. The lenticels will then develop, especially those which are submerged (in Catalpa), showing the method of splitting, the loose tissue and the green color of the inner cells, previously to the development of the bud.

[3] As in the experiment in Detmer-Moore, p. 172. An aspirator is used.

relation of external features of the twigs as above noted with the internal structure.[1]

Method of determining the age of a tree. Possible sources of error.

The apical region of the stem; the exogenous origin of branches. Demonstration of sections illustrating these points.

*b.* Functions of the stem.

(1) As a mechanical support of leaves and other parts.

Rigidity of the stem produced by turgor, setting up tissue tensions.

Review of observations on osmose.

Experimental observation of herbaceous stem.[2]

Measurement of a piece of stem (or petiole); measurement of the central and peripheral parts after their separation by longitudinal splitting.

Effect of plasmolysis of the same parts; measurement before and after plasmolysis compared.

The artificial cell.[3]

Microscopical observation of a transverse section of such a stem, showing the absence of thickened cell walls in the central portion and the cells with thickened angles (elastic tissue) in the peripheral region.

Rigidity of the stem produced by the development of mechanical tissues (thickened cell walls).[4]

Comparison of rigidity of a woody stem with an herbaceous stem by tests of resistance to lateral traction, both before and after removing the outer zone of tissue. Comparison of herbaceous and woody stems living and dead.

[1] Students should be asked to verify their own conclusions derived from a study of external marks, by counting the rings of growth after making transverse cuts with a keen knife.

[2] A calla-lily peduncle, rhubarb petiole or arisæma peduncle is good.

[3] Can be made by filling a piece of sausage skin with strong molasses, tying up both ends, and placing it in water.

[4] Among others, the stem of smilax is very valuable, especially for the microscopical examination of thickened cell walls.

Distribution of mechanical tissues in the stem. Relative effectiveness of various arrangements. The condition in climbing plants.

Comparison of solid and hollow stems, e.g. grasses.

(2) Transportation of water and food materials.

From the soil to the upper parts of the plant. The path of water in the stem and leaves determined experimentally. Rapidity of ascent.

From the leaves to the lower parts.

From water culture experiments it has been determined that no organic materials are absorbed from the soil by the roots.

Determination of the presence of starch in subterranean parts.

(Evidence from experimentation upon leaves will complete the chain of evidence.)

(3) Stems as climbing organs (e.g. Ampelopsis).

(4) The storage of foods.

(*a*) Stems which are of less importance as mechanical agents, but which contain a larger amount of reserve food, and which usually grow along, or below, the surface of the ground. (See also under "Buds.")

(*b*) Stems showing a large amount of modification due to special activity in food storage, e.g. potato, crocus, corn.

(5) Water storage, e.g. Cacti, certain Euphorbias, and Salicornia (containing large special water cells).

(6) Vegetative reproduction, e.g. crack willows; separation of branches by decay, runners.

(7) Production of stem from roots. The condition of a neglected orchard.

*c.* The leaf.

A typical foliage-leaf.

External features: form, venation, comparison of leaves of monocotyledons and dicotyledons, variation. Mechanical function of venation determined experimentally.

Ecological relation of form and leaf position; relation

also to the position of the branch. Correlated leaf movements.

Internal structure.

Epidermal tissue, the structure and distribution of stomata.

Mesophyl: palisade and spongy tissue; intercellular spaces.

Vascular tissue.

*d.* The functions of a typical foliage leaf.

Transpiration.

Determination of the fact and estimate of amount of loss of water from leaf surface by weighing experiment.

Does water pass off both sides with equal rapidity? Determined by using filter paper impregnated by cobalt chloride.[1] Correlate with observations on the distribution of stomata.

Demonstration of transpiration by means of a bubble in a capillary tube.[2]

Respiration.

Recall the experiment demonstrating the need of oxygen by inhibition of growth of oat seedlings.

Demonstration of the production of carbon dioxide by the growing plant.[3]

Demonstration of passage of gases through stomata by displacement of air.

Photosynthesis.

Relation of starch formation to light as shown by applying the iodine test to etiolated and non-etiolated leaves.

[1] Take two leaves of the same kind with no free moisture upon them. Place one on a table dorsal side up, and the other vice versa, put a small square of perfectly dry cobalt paper on each; cover with a piece of glass and watch for the discoloration. The cobalt paper is made by dipping filter paper in a 10% solution of cobalt chloride and drying.

[2] MacDougal, D. T., *Experimental Plant Physiology*, Exp. 27, p. 23.

[3] Using barium hydrate as an indicator. The experiment outlined by Detmer-Moore (*Practical Plant Physiology*, p. 260) has been used and found very valuable. The simple and useful experiment of extinguishing a flame by inserting it into a volume of air in which seeds have been germinating is also used.

The effect of light upon chlorophyll; the action of a screen of leaf-red.

Leaves with specialized characters.

Arrangements for conserving water supply.

Thickened cuticle (e.g. Ficus).

Mucilage cells (e.g. Commelina).

Comparison of rate of wilting of a leaf of Commelina, and one of Fuchsia or Impatiens. Demonstration of mucilage cells in a transverse section. Notice mucilage on crushing the leaf between the fingers.

Reduction of transpiring surface.

Vertical position of leaves; phyllodes.

Leaves with water excreting glands (e.g. Fuchsia, Tropæolum).

Leaves with nectaries (Ricinus, Pteridium). Artificial nectary.

Leaves showing special mechanical adaptations (e.g. grass,[1] pine); as a clinging organ (e.g. pea).

The so-called carnivorous plants (e.g. Sarracenia, Nepenthes, Pinguicula, Drosera).

Insect traps (live cages) (e.g. Utricularia, Frullania, see beyond under Liverworts).

The ecology of leaf movements. Experimental study of leaf movements in Mimosa pudica.

The fall of the leaf.[2] Demonstration of prepared section.

Vegetative reproduction by means of the leaf (e.g. Bryophyllum, Begonia, certain ferns).

*e.* The bud.[3]

Review of structure of the embryo, especially regarding the plumule as a bud.

[1] For a discussion of the adaptive features of the grass leaf, see F. Le R. Sargent, *Corn Plants; their Uses and Ways of Life*, pp. 11-30.

[2] See in *Living Plants and Their Properties* the essay, "Leaves in Spring, Summer and Autumn," by D. T. MacDougal.

[3] The study of buds is postponed till the leaf has been studied. This is of considerable importance in order to the better understanding of the morphology of the bud, especially of those (e.g. Liriodendron or tulip tree) in which the stipules are used as protective organs.

Buds on stems of continuous growth.

The winter buds (hibernacula) of water weeds (e.g. Utricularia, Elodea, etc.).

The winter buds of perennial plants.

Structure of the bud; arrangement of the bud scales; waxy or resinous coatings.

Comparison of positions of leaf scars and bud-scale scars.

The part of the leaf to which the bud scale corresponds.

The storage of food substances in and near the bud. Apply proteid, starch and sugar test to a thick median longitudinal section.[1]

Buds as organs of reproduction (e.g. onion, bulbils of lily species).

### *II. A Study of the Types of the Groups of Plants*

1. SPERMATOPHYTA: ANGIOSPERMS.

*a.* The willow.

The inflorescence: the axis (plumule) and the relative length of flower stalks (pedicel); position.

The flower: number, size and arrangement of the organs; dicœcism; diagram of staminate and pistillate flowers.

Ecology: adaptation to insect pollination; observation of the trees and insects at work (field work); dissemination; the origin of the pappus.

*b.* Hazel and alder; elm and maple. Using the willow as a type, compare it with these four with reference to

The inflorescence.

The structure of the flower; dicœcism and moncœcism, floral diagrams.

Presence or absence of nectaries, the character of pollen (sticky or dry and powdery), character of the fruit and method of dissemination.

[1] It is important and valuable here to point out the analogy between the seed and the bud. A discussion of the subject will be found in the *Memoirs of the Torrey Botanical Club*, Vol. 2, No. 1, "Reserve Food Materials in Buds and Surrounding Parts," by Bryon D. Halsted, pp. 1-26, with 2 plates.

*c.* Calla lily (Richardia).[1]

Inflorescence: the thickened axis and shortened pedicels; crowding of the flowers.

The structure of the flowers.

Ecology: odor, adaptation for pollination, the rapid squeezing out of mature pollen, beautifully seen in this form.

Growth of pollen tubes.[2]

*d.* Hyacinth.

Inflorescence.

The flower: how many sets of organs, and their relative position? are they united or free? their relative position on the receptacle; diagram of transverse and longitudinal sections of the whole flower.

Method of pollination in the Liliaceæ of which this plant is a type. The odor, color.

*e.* Cypripedium.

The mechanism for effecting cross-pollination with the aid of insects is demonstrated by means of growing plants and prepared specimens.[3]

The homology of parts between the lily and orchid flowers is demonstrated.

*f.* Strelitzia (Iris).

The mechanism for pollination in these forms also is demonstrated by means of prepared specimens or living material.[4]

[1] Can be obtained at this time of the year from florists. The Jack-in-the-Pulpit (Arisæma) or golden-club (Orontium) can be obtained in the field now, or a little later.

[2] The production of pollen tubes is quite rapid in a 5% sugar solution. They are not favorable, however, for a study of the pollen tube structures.

[3] The flower in longitudinal section, and the various structures taken separately, may be displayed in a specimen jar affixed by means of gelatine to a piece of ordinary glass, and preserved in 5% formaline. The structures may then be examined from either side. See previous note.

[4] Special exotic forms, such as Strelitzia, are often difficult to get, although this form is common enough in glass houses. The writer has found that if specimens are obtained when opportunity offers and are properly preserved, much valuable material may be made available.

According to the same general plan of work as seen above the following forms have been studied. These particular forms are chosen on account of their availability, and may be supplanted by others, as circumstances permit or demand.

*g.* Buttercup.
*h.* Geranium.
*i.* Abutilon or Malvavistrum.
*j.* Some leguminous flower.
*k.* Azalea.
*l.* A cactus flower (demonstration).
*m.* Begonia.
*n.* Dandelion and field daisy.

2. GYMNOSPERMS.

The fir, spruce or pine.
The staminate and pistillate inflorescences.
Pollination.
The morphological meaning of the " fasicles " in pines.
The habit of these plants.

3. PTERIDOPHYTA.

*a.* Aspidium.[1]
Stem (rhizome) and leaf: their relative position.
Leaf (frond): examination of the venation, comparison of venation in several different forms to discover the points of resemblance and general character of fern venation.
Sorus: position of sorus with reference to veins; its form and position in various genera.
Indusium.
Sporangia and spores: movements of the sporangium under drying, and the scattering of the spores.
Prothallium (gametophyte). Germination of the spore

[1] In carrying on the work in ferns no particular type is adhered to, because some forms are more favorable for the study of certain points than others. For example, a pot of Polypodium is used for the demonstration of the rhizone.

and the development of the prothallium.[1] In a mature prothallium, find —

Rhizoids.

Antheridia,[2] and

Archegonia in surface view, under medium magnification.

The motile antherozoids[3] and the opening of the archegonia are demonstrated.

The developing fern plant (sporophyte): examination of stages in development.

*b.* Equisetum.

Demonstration of different species by means of herbarium material.

Movements of spores by means of hygroscopic elaters.

Demonstration of prothallia.

The following types are demonstrated by means of museum preparations. Nothing more than an examination sufficient to get a general idea of the form of the plants is required. This is therefore done very briefly.

*c.* Isoetes.

*d.* Marsilia (venation).

*e.* Pillularia.

*f.* Salvinia.

*g.* Azolla.

Herbarium specimens of the following genera are exhibited. Additional points of study are noted.

[1] Demonstrated by means of charts, prepared specimens mounted in series (showing also the development of the sporophyte) and growing material.

[2] The student is greatly helped by seing a properly prepared longitudinal section of a mature prothallium.

[3] These can be obtained with ease if the prothallia, which must be mature, are kept for a day or two without being supplied with fluid water (by keeping them under a bell jar) and then subjecting them to a little more drying just before examination. They should be examined in water. Often the antherozoids will be caught in the rhizoids, and will then move about in a small area. They may then be examined with a higher power. If a good number are seen swimming about, the addition of a small drop of eosin-iodine, or simply iodine (in water with Potassium iodide) will kill them. They can then be examined more carefully, and the cilia, sac and spirals demonstrated.

*h.* Lycopodium.

Difference between foliage leaves and sporophylls.

Spores (all of one size).

*i.* Selaginella.

The two different sizes of spores.

At this point a brief sketch of the geological history of the pteridophyta is given, attention being called to the character of the vegetation of the coal period, and the nature and origin of coal.

4. BRYOPHYTA (the true mosses).

*a.* Polytrichum.[1]

Gametophyte. Compare its general character with those of the prothallium of the fern, as to the

Production of leaves; their position on the stem.

Stem.

Rhizoids.

Sporophyte. Its growth upon the gametophyte (compare with the fern), and its gross structure.

Seta, with the soft green foot embedded in the gametophyte.

Capsule, with its green tissue and hairy 'calyptra'; remove calyptra and note operculum, and, beneath it, the diaphragm.

In order that some of the more important features of mosses may be readily seen, the following types are used for the purpose of demonstrating the structure indicated.

*b.* Pogonatum: protonema: color of underground and above-ground parts.

*c.* Georgia (Tetraphis) pellucida: peristome of four teeth; gemmæ.

*d.* Funaria: Movements of the peristome.

5. HEPATICÆ (LIVERWORTS).

*a.* Radula.[2]

[1] Chosen for its size and ease of handling.

[2] Any foliose liverwort which produces sporophytes freely may replace this form. Cephalozia and Porella are two of these. The former may be found in moist place on decaying wood; the latter on the trunks of trees.

Gametophyte. Compare the leaves with those of Polytricum as to

(a) Arrangement on the stem;

(b) Relative complexity of structure, shape.

Sporophyte.

Insertion on the gametophyte.[1]

Seta; its weak, evanescent character, and its rapid growth after the maturity of the capsule is reached (compared with moss).

Capsule: absence of green tissue, method of dehiscence, elaters and spores. The remains of the neck of the archegonium. The calyptra at the base is seen to be a part of the gemetophyte. Compare with moss.

The following forms are examined with reference to the special points mentioned.

*b.* Frullania: adaptations of the leaves for holding water and minute animal forms.

*c.* Scapania:[2] gemmæ produced at the tips of the leaves (upper lobes).

*d.* Marchantia, and

e. Lunularia: the more obvious features of these two forms are briefly examined; more especial attention is given to the gemmæ.[3] Attention is called to the relative complexity of the gametophyte of the foliose and thallose kinds of Hepaticæ.

6. FUNGI.

The vegetative organs of the Fungi.

The physiological characters of Fungi:

Lack of chlorophyll.

[1] Demonstrated by sections and micro-photographs.

[2] Scapania grows on moist, shaded banks, and may be kept in the laboratory in good condition under a bell-jar all winter. So also may several others.

[3] Any greenhouse will afford materials of Marchantia and Lunularia. The latter is not to be found wild. Marchantia, on the other hand, is to be found rather easily, on moist clayey soil in open places. Young plants growing from gemmæ may be obtained readily, by sowing the gemmæ on soil under a bell-jar.

Saprophytism, parasitism, symbiosis, haustoria (see also above under mycorhiza).
Alternation of hosts.
Economic importance.
Types of Fungi as follows:

*a.* Agaricus.
Examination of a series of specimens of the edible mushroom showing:
The mycelium,
Developmental stages of the sporophore as whole objects and in longitudinal section.
The gills and spores.
Comparison of the three types of higher Basidiomycetes:
The gill-bearing, e.g. Agaricus,
The tooth-bearing, e.g. Hydnum,
The pore fungi, e.g. Polyporus.

*b.* Examination of
(a) Leaves infested with a rust (Puccina or Uromyces),
(b) Of the spores under magnification.

*c.* Morchella (edible morell).
Habit, gross features.
Asci, ascospores.

*d.* Sclerotinia: economic importance.
Demonstration of sporophores and sclerotia.

*e.* Lichens.
Examination of types of the more important biological groups, determining in each case the ascocarp.
Incrusting lichens of rocks and bark.
Foliaceous lichens of the ground and tree stems (Sticta, Peltigera).
Fruticose lichens: Usnea, Cetraria Islandica, Cladonia.
Microscopical examination of a gelatinous lichen (Collema) in order to demonstrate the algal symbiont.
Symbiosis in lichens.

*f.* Claviceps.
Habitat and poisonous qualities.

*g.* Cordyceps.
Habitat, external features.

*h.* Penicillium.
Examination of cultures.
Conidiophores and Conidia.

*i.* Microsphæra alni, the lilac mildew.
The fungus as it appears on the leaves of the host.
The perithecia, asci and ascospores.

*j.* Mucor.
General appearance of the plant as growing. Its habitat.
Mycelium: structure, absence of chlorophyll.
Sporangia and spores.
Demonstration of zygospores.

*k.* Saprolegnia.
The growing plant, habitat, source of food.
Mycelium.
Sporangia and spores.

*l.* Yeast.
Culture.
Microscopic appearance.

*m.* Algæ.
Spirogyra.
Structure of the plant.
Reproduction by means of zygospores.
Vaucheria.
Structure of the plant.
Sexual reproduction.
Demonstrations of various forms of the green, brown and red algæ.

*n.* Schizophyta.
Demonstrations of bacteria.
Cultures, natural and pure.
Microscopical preparations.
Fission algæ.
Oscillaria: form, movements.
Relation to quality of water supply.

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## GEOGRAPHY

## IN THE

## HORACE MANN SCHOOLS


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## ANNOUNCEMENT OF VOLUME II — 1901

**No. 1 January** — *Biology in the Horace Mann High School.* — FRANCIS E. LLOYD and MAURICE A. BIGELOW.

**No. 2 March** — *Geography in the Horace Mann Schools.* — RICHARD E. DODGE and Miss C. B. KIRCHWEY.

**The following numbers in preparation:**

*Child Study.* — *Sources of Materials and Syllabi of College Courses.* — Professor E. L. THORNDIKE.

*Syllabi of Teachers College Courses on the Theory and Practice of Teaching.* — Professor F. M. MCMURRY.

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## EDITORIAL NOTE

The publication of a comprehensive outline of a course of study, such as is given in the current number of the RECORD, has a distinct value in presenting to teachers a general survey of the field. It shows more clearly than can be shown in any other way the relations existing between the various stages of a school course; it gives a setting for the work of each teacher and each grade. As a teachers' guide, therefore, if for no other reason, it is worth while to do such a piece of work.

There is, on the other hand, a certain disadvantage in publishing so complete a syllabus of a course which, in the nature of things, must be constantly shifting. In the first place it tends to fix permanently what is temporarily expedient. And, second, it suggests the general adoption of a plan which is obviously adapted to the specific needs of the Horace Mann Schools. I assume, however, that the readers of the RECORD are intelligent enough to use these articles in the right way. In so far as they disclose obvious defects in the work of the Horace Mann Schools they contribute directly to the solution of one of the chief problems set before this journal; and if they possess any merit either of originality or scientific application they will serve still higher ends.

It will be apparent to the experienced teacher that these outlines indicate an amount of work impossible of execution in the

time allotted in the Horace Mann Schools if every part were to be elaborated in detail. Teachers are free to select such portions for special emphasis as best suit the needs of their respective classes, but care is taken that what is done shall be typical and capable of application in other items of the course. Within the limits defined by the Superintendent in the curriculum and by the Supervisors in the courses of study (as published in the RECORD), each teacher guides his class as he thinks best. The function of the Supervisor is to assist the teacher in the selection, arrangement and presentation of materials of instruction, but what shall be actually presented and the manner of its presentation is left to the teacher under the direction of the Principals and Superintendent. Hence these courses of study, although prepared by the Supervisors, are largely influenced by the practical experience of the teachers in the Schools. In a very real sense, therefore, they are Horace Mann School courses.

I have been asked the question whether these courses are actually in operation in the Horace Mann Schools or whether they are ideals which we are trying to realize. This note is an answer to that question. They come as near to the actual practice of to-day as we know how to express it; to-morrow our condition may be different and we shall not hesitate to modify our practice accordingly.

JAMES E. RUSSELL.

# THE COURSE IN GEOGRAPHY IN THE HORACE MANN SCHOOLS

By RICHARD ELWOOD DODGE, Professor of Geography in Teachers College, Columbia University, and Supervisor of Geography in the Horace Mann Schools; and CLARA B. KIRCHWEY, Instructor in Geography in the Horace Mann High School.

The course in geography in the Horace Mann School is naturally divided into two parts, that in the Elementary School and that in the High School. Geography holds an important place in the Elementary School from the third to the eighth year inclusive, and physical geography is an elective study in the fourth year of the Secondary School. These two aspects of the field will be considered in turn.

## Elementary Course

The supervisor or superintendent who has to outline a course in geography for the elementary school is confronted with a task neither easy nor small. The breadth of the subject is so great and the precedents already established in reference to geography are so strong that it is very hard to enter the field unbiased as to method of treatment, and free to organize a course that shall be strong, progressive, sensible and practical. Such an outline can only be made by carefully deciding upon certain fundamental principles and then following those principles. These fundamental problems include — the point of view that a true conception of geography demands, the determination of what the children ought to secure of value from the study of geography, the relation of the subject to other subjects in the curriculum, and finally the method of treatment that will ensure the best training of children in geography, both from the standpoint of their present needs and their future probable needs.

### *Guiding Thoughts — The Point of View in Geography*

Geography, whether viewed as an elementary or a university subject, is best defined by Dr. H. R. Mill[1] as "the study of the earth in its relation to man." It is well to remember, however,

[1] H. R. Mill, *The Realm of Nature*, Scribner's, 1897, p. 331; and *The International Geography*, Appleton, 1900, p. 2.

that man cannot exist without other forms of life, so that the life side of geography is greater than the mere human side. The earth is the stage, and life is the play that is being enacted thereon. It is not necessary, however, for the elementary pupil in geography to make an exhaustive study of the stage and its workings without reference to the play; neither should it be his task to study the play in all its details without reference to the stage. Such special studies may be considered to a certain degree legitimate in elementary schools, but cannot logically be included in geography. A child studying the origin of land forms, or the movements of the winds, is not studying geography, but physical geography, which is one of the fundamental departments of geography as a whole. Again, the child studying the social interrelations of neighbors, or of distant strangers, or the principles of government, is not studying geography, but the elements of sociology or history. Geography work in schools must include certain features from both these lines of thought; but unless the work be related in such a way that the study of life consequences leads to a study of earth causes, or *vice versâ*, the work has but little geographical significance.

The teacher, however, who makes his course by appropriating equal amounts from both sides, thinking that such a mingling may form a good compromise course, pleasing to all and combatted by none, makes a serious mistake, as his course may have no individuality or strength unless the blending of the threads be such that the causal relation of one series of facts with the other be a very prominent part of the work. The so-called "causal notion"[1] gives the teacher the cue as to the arrangement of the work, for geography, according to our definition, emphasizes the *relation* of earth and life. The causal idea must be prominent, and increasingly prominent throughout the work; but it is not the sole determinant of the order of topics or emphasis to be given to any topic. We must remember that we are primarily teaching *children* geography, and that we are *not* training scientific geographers, though we must train children scientifically. The order of facts and principles that would be presented to the more mature student must, in many cases, be rearranged to fit the needs, the abilities and the interests of young

[1] "The Causal Notion in Geography," F. M. McMurry, *Journal of School Geography*, Vol. I, No. 2, February, 1897, p. 48.

children. This does not mean, however, that there is to be no causal relation between the facts presented, but rather that the selected facts are to be arranged so as to bring out the causal relation in such a way that both the idea and the getting of the idea shall be of value to the pupil.

It is sometimes stated that the children must lead and guide us in our work; but perhaps it would be nearer to the truth to say that we teachers should lead and guide our pupils along lines of progress that experience has shown are of most immediate profit to the individual students, and most capable of laying the necessary foundation that future work in the subject demands. We must allow the children's interests and experiences to suggest to us the point of departure to be followed in introducing them to new fields; but we must not permit the momentary enthusiasm of the class to lead us away from the general line of progress necessary to good work in the subject. Such an aside may be of great momentary interest, but it is not usually to be pardoned if the pupils' future mental ability is jeopardized by such a digression. Our plan must be so arranged in large and small points that we lead the pupils by the lines of *least resistance,* but *not* least effort, from the unrelated and little known, but familiar facts, to the causally related known or unknown. This is sometimes summarized to the effect that " we must not follow the logical, but the pedagogical order," as if the pedagogical order were not logical, but illogical. Such is, however, a misstatement, and gives an unnecessary, wrong conception of the attitude of the best specialists in elementary education toward strong and scientifically ordered subject-matter. A pedagogical order that is not at the same time logical does not add strength but weakness to the cause it represents, and will not long stand the test of educational scrutiny and criticism.

### *Aims in Geography Work*

We may say that our general aim in geography teaching is to give our pupils an understanding of the more important geographical conditions of the world, causally considered. This general statement, however, deserves analysis, for a study of geography should give the pupil something that will be of value to him long after a large proportion of the facts gained in the

study has passed from his mind. The leading aims of the course of study as a whole, and of the several parts should be the imparting of a knowledge of geography, and the power to make use of that knowledge in daily life. These two words, *knowledge* and *power,* are key words that suggest many details. A knowledge of geography does not mean merely information in reference to geographical conditions, but rather an understanding of geographical principles and the larger and more important facts that illustrate the principles.

1. KNOWLEDGE. — Such an understanding of geographical conditions is not given until the information that is acquired is so arranged and absorbed by the pupil that it becomes a part of himself, to be used in every-day life as a valuable knowledge that makes his life more full and useful. This aim must be realized in part each year, and not merely looked forward to as a climax of five or six years' work in school geography. The training must be such at all times that the facts and principles are immediately usable, which suggests that a course must be so arranged that a child leaving school at the end of the fifth or sixth year has gained something helpful in life.

2. POWER. — Next in importance to knowledge as an aim, as has already been suggested, is power. By power is meant the ability to think clearly and accurately; to reason from known to unknown; to test the geographical facts presented in text-books and newspapers, and to choose from the mass of perhaps illogical and perverted yarns the grain of truth that is worth being acquired as a new mental possession. Power also includes the ability to seek new material in all the better sources of reference, and to organize and apply the truth in an impartial and accurate way.

The knowledge of what are the best and most reliable books and atlases, the power to use these, and the ability to read and interpret maps of all the more common kinds, is a very important part of a pupil's gain from his school work. Training in seeking new material makes the pupil independent, gives him an impetus to seek the truth, and may impress upon him the fact that ought to be impressed, that his text-book is not infallible or all-comprehensive.

From such work ought also to come the feeling that not all is yet known in geography, and I can think of but few more

serious mistakes than to leave pupils with the feeling that they have gained from a text-book all there is to be gained in reference to any particular subject. The demand for more is a healthy want to be left in a pupil's mind, and this can be left if the pupil has had training in coming in touch with many sources of information, some one of which may have given him an inspiration and a new insight into the subject that makes him an enthusiast. The pupil who has had such training is less apt to jump at conclusions, more liable to be open-minded, and willing to look for and acknowledge the good points of an opponent. Such a power over one's self comes with good scientific training, to be gained not only from geography work, but also from history and nature study, if properly taught. A part of the task of the geography teacher, however, is to accept a large share in such training.

There are certain other so-called aims in geography teaching that are really overlapping phases of the two main aims thus far presented. They deserve especial mention here, however, because they emphasize the human element in geography work that is liable to be overlooked or too seriously minimized by those who believe in emphasizing the causal notion in geography. One of these points is suggested by the thought of "interdependence" — i.e., the general relation of individuals and nations — and the other by "training for citizenship."

3. INTERDEPENDENCE. — Inasmuch as geography has to do with the relation of man to the earth, and thus with a comparative study of the conditions of peoples over the world as a result of their environment and opportunities, geography can offer, perhaps better than any other subject in the common school, an opportunity for study and emphasis of the necessary interrelations of peoples and individuals, the dependence of one person on another, and the interdependence of all. Through such a study of interdependence comes a rational and sympathetic understanding of the ways of distant peoples, who ordinarily are merely objects of curiosity to pupils. The study may then become one where interest and not curiosity is appealed to, thereby making it possible to emphasize the causal side of life conditions.

So far as social dependence is a result of varying conditions of physical environment that necessitate varying methods of life, different occupations and industries, and perhaps different mental traits and national characteristics, the understanding of such

social dependence may very rightfully be a subsidiary aim in school geography, particularly in the early years. When, however, we go farther and study social dependence without reference to the controls that allow or necessitate such dependence, or when we try to have our lessons closing with moral tales, we are perverting the cause; and, indeed, the reiteration of moral tales as corollaries of any class work may, except in the hands of a master, develop in the minds of the pupils an abhorrence of the subject that stands to them solely, perhaps, as the peroration to a sermon on a familiar and much used text. A true conception of the vast and complicated series of national or community interrelations from the economic or any other standpoint must be the growth and development of years, coincident with the development of a broadening and fuller mind, richly equipped with the knowledge that may be made the foundation of such an understanding. Such a knowledge of society cannot be, with profit, more than suggested in the early years.

4. CITIZENSHIP. — Recent discussions in general pedagogy as well as concerning geography teaching emphasize the necessity, as has been suggested, of our schools training their pupils for citizenship. If this means, as some would have us believe, that geography includes a detailed study of the social conditions surrounding the individual (the play), a study of society as an institution, of government and the duties of a citizen toward the government, or even a detailed study of industries (especially of regions more or less remote), without any thought or emphasis of the stage which has formed the background, then the scope of geography has been very arbitrarily increased beyond the limits of its true field, and without necessarily bringing about the end in view. "A man may possess a vast knowledge with regard to the workings of our social and political machinery, and yet be absolutely untrained in those things that make a good citizen. . . . As ordinarily taught, they (Sociology, and Politics, and Civics, and Finance) tend to fix the attention of the pupil on the mechanism of free government rather than on its underlying principles; to exaggerate the tendency, which is too strong at best, toward laying stress on institutions rather than on character as a means of social salvation."[1]

[1] "Political Education," President Arthur T. Hadley, *Atlantic Monthly*, August, 1900, p. 145.

If, however, training for citizenship means, not merely the understanding of the elements of society, but the ability to be good citizens, then geography work can well add much to the cause; not, however, wholly through its subject-matter, but in part through the training in scientific thinking involved. If geography can give the young citizen the knowledge that makes his combat with his social and physical environment more intelligent and more successful through giving him a better understanding of the geographical controls of life over the world, and the conditions possible within the limits set by the controls, if it can give him the foundation of a future broader and richer culture, if it can give him training in clear and careful thinking, in weighing pros and cons, and in acting sanely and vigorously according to his well-founded convictions, then it can give training for citizenship of the best kind.

### *The Larger Plan of the Course*

Guided more or less by similar ideas in reference to the proper scope of school geography, leaders in the subject have, within the last few years, come to divide the course into several distinct and yet related parts. The divisions in vogue in the different parts of the country are, however, very much at variance, so that there is by no means unanimity of opinion, particularly in reference to intermediate and upper-grade work.

Good pedagogy and common sense both decide that a child should enter into the study of geography through the door of his own home and life, and that home geography should thus be the first division of the subject. For the same reasons the child should work outwards from the home geography and gradually be led into a study of larger and larger world units.

In this second step, however, there is a great difference of opinion, some believing that the home geography should spread outward from the schoolroom in concentric waves, like the waves formed by a stone thrown into the water, expanding from the schoolroom into the schoolyard, the street, the ward, the city or town, the county, the state, the nation, the continent, the several continents, and the world. Others believe that the line of advance should be, like the rays of a spider's web, ever radially from the familiar home locality to the unfamiliar distance, along

the paths of least resistance and deepest interest, until the whole world, and the world as a whole, are related to the home region and to each individual pupil. The choice between these plans depends largely upon the contents and methods of home geography. In either case, however, the climax of this preliminary work is a view of the world as a whole, and either plan offers a host of serious and perplexing problems. In the Horace Mann School the preference is for the second plan, as later announcements of the course in detail will illustrate more fully. Thus the course under consideration involves the study of home geography as the first stage of advance, which merges gradually into a study of the world as a whole, as related to the home and to the individual pupil. (Stage II.)[1]

The third stage in the course is very generally conceded to be the study of the continents; but the order in which the continents are to be studied, the manner of treating them, the number of times they are to be considered, and other special problems are by no means settled. The custom has been until recently to "do the continents twice," as the expression is, once from the standpoint of the smaller or primary book, and once from that of the larger or advanced book. Furthermore the treatment the second time has frequently been the first treatment repeated, without much modification and with some additions. Partly as a result of this, and partly for other reasons, geography work has frequently been looked upon by teachers and taught as a compulsory nuisance upon which much time, energy and ill feeling were wasted.

The opposite plan of treating the continents but once in any detail, which has been ardently promoted by a few teachers within the last few years, has many points in its favor, and many against it. While repetition in concentric circles is to a large extent avoided, it seems impossible, according to this plan, to treat the more important continents at the time when they can be studied

[1] The course is divided into stages rather than by years or grades, because it is believed that the geography course as a whole is one unit, in which there are rhythmic pulsations that bring now one, now another phase of the subject uppermost; and that though the continuity of the subject is interrupted annually by the long vacation, there is not necessarily any reason, from the standpoint of the pupil, why the character of the material given, or the method followed, should seriously be changed each summer.

most deeply and fully. It is irrational to postpone the study of North America and the United States to the later grades, for the children should know their own country early, that they may understand every-day affairs as chronicled by the press, if for no other reason. It is also somewhat illogical to study the United States with great thoroughness in the early grades, when from the nature of the subject and the children the causal side of the work cannot be emphasized to the best advantage. Furthermore, the writer has not been able to plan a course according to this method that will ensure a child leaving school at the end of the fifth or sixth year having a general knowledge of the world such as he ought to have.

Either method has disadvantages, but it is believed by the writer that the first offers the fewer and has many superior advantages, provided the work is so arranged that the second treatment of the continents (or the more important ones), though based on the earlier treatment, is from an entirely different point of view.

Another difficulty in this stage and the following is in reference to the teaching of physical geography: shall this division of the subject lead or follow, shall it be detailed or general; shall it receive more or less attention than political geography, are some of the few questions along this line that have been ardently discussed in the last decade.

In the mind of the writer, physical geography has a right to a large amount of consideration in elementary schools. It must not, however, be taught as an end in itself, but as a means to an end, and that end, in the upper grammar grades, should be the causal understanding of geographical conditions over the world. Physical geography also has a place in the work of beginners in geography; but its place is not all-important. It must be brought in slowly as an entering wedge that shall be driven deeper as needs may require during the succeeding years, but which shall not be driven "home," perhaps, until the later intermediate years.

The arrangement of the facts of physical geography in the elementary school must be decided by the scientist, the leader in child study, and the practical teacher working together. The scientist should determine the field to be covered, and, in a general way, the order of steps to be followed in the work, and should

see to it that the pupils receive training in accurate and scientific thinking; the child-study expert should be able to show how the selected facts may be used with the greatest effect and the least waste of energy on the part of teacher and pupil; and the practical teacher, who knows his children better than any one else, and who alone sees the practical possibilities, should select the details, arrange them so as to be of the greatest value and assistance in the development of the pupils, and yet so rationally that neither the pedagogical expert nor the geographer can offer valid criticism or rebuke.

The way will be made more easy if, so far as possible, in physical geography, as in other subjects, the children be led forward so gradually and systematically that need is developed for a fact or a principle before it is presented. Children should be led and not driven to the study of geographic controls. To follow such a progressive plan means in the early years a different method of study from that in the later years, when the children can work longer at a given task without variations, and when they can think more logically and consecutively. Whatever is done at any stage should be done in such a way that causes and consequences are necessarily related, though it is wise to remember that the consequences that deserve emphasis are not always the physical, but more often the human consequences following certain physical causes. In the earlier years pupils may study the consequences and gradually be led to see the fundamental causes of topography, climate, drainage, etc., that exercise control over life. Such a plan rightfully followed should give good, practical mental training, should keep uppermost the human phases of the subject, and throughout a need may be created in the children's minds for a more thorough study of the causes in later stages.

Such a study of the physical facts in a somewhat extensive manner naturally follows, and in turn the elements of physical geography should be followed by a more full and careful study of the consequences of the present and past time, that can only be really appreciated as they are seen in the light of their environment. We might express it in some such way as this: that in the early years the children should be led to see some causal arrangement in the apparent chaos of physical, industrial, and social conditions with which they are always surrounded, thereby

laying the foundations and the need for the study of pure science — the causes. After the causes have been elaborated as fully as time and the needs of the pupils allow, the pure science (physical controls) should be made the basis of work, so that the applied science (history, civics, and social conditions) may be taught understandingly.

It is not intended to imply here that present social conditions are entirely due to the physical environment, but that the physical environment should be given the emphasis due it in each case; that where physical controls are important, for instance, in determining a boundary, they be noted, and when politics have fixed a frontier, that the failure to follow the natural boundary be also noted and accounted for.

One advantage of such an inversion of the plan of procedure is the variation in method of study as the years go on. Geography in the upper grades thus taught is not merely a duplication of the work of the earlier years, with more details to create work for the pupils; it becomes more rich and more full of significance, and the method may be made so different that pupils hardly realize they are covering the same ground. Instead of the circle outside a circle, or concentric method, it may be said that a circle is drawn in the early years; that then the circle is turned inside out, like a glove, and that the later work is built around it.

Furthermore, such a plan allows the human conditions to be emphasized in the earlier years, when the children are as a rule interested in what people are doing. It should be noted, however, that they are also interested in *why* people do certain things, which is one of the reasons for leading from consequences out to causes. As soon as we can get a why, there is a logical reason for giving the causes, and our children are thinking ahead and creating a need for more and richer food. They cannot become parrots or mere absorbing sponges. Children do not ask why, however, until they have seen the fact to be explained, which suggests that the study of consequences should precede the study of causes in the early years.

For these reasons Stage III in the outline under consideration is devoted to a study of North America, Europe, etc., from the standpoint of centres of life, and the reasons that have determined certain industries and occupations to be prominent in some regions, and others in others. The human relations to the earth

are made the most prominent part of the work, and through the study certain elementary generalizations are worked out as to the reasons for the various centres and their character. Such a treatment gradually introduces the child to the importance of the physical features in determining the present geographic conditions, and the way is paved for taking up the physical features as things by themselves worthy of analysis and classification, that they may have them at ready call in the later continental work.

In the earlier work of Stage IV the physical controls of life, that have been worked out in geography and nature study in the earlier years, are reviewed and elaborated as they are needed in the study of Africa from the standpoint of physical features, the object being to bring the hitherto somewhat scattered facts into their logical relation, so that they can be seen in the proper perspective.

As the human consequences may lead to a study of the causes, so the physical causes naturally lead up to the consequences, considered not from the social and industrial side, as formerly, but as illustrations and elaborations of physical laws. Thus the treatment of the continents in the later part of Stage IV is topical, the topics being such as to make the human conditions distinctly related to the physical features. Such a topical method of treatment from the physical standpoint allows the very best kind of mental discipline, and secures an understanding of the geographical conditions through the training of the rational, rather than the mechanical memory.

The work of Stage IV is brought to a close and tested in Stage V through the study of Europe, from the standpoint of principles of control, and in a comparative way. Stage V is thus a summary and application of all the previous work, so as to make the relations between the several continents stand out in their proper perspective. Throughout Stages IV and V much training is given in seeking information in sources outside the text, in studying maps and atlases, in weighing facts, and in applying the materials previously gained. Thus power as well as information, and perhaps even more than information, is acquired.

In conclusion it may be said that the writer strongly believes in the following division of geographic work: that the study of

nature and of home lore in the first years of school life should be introductory to home geography (Stage I); which should lead up to and merge into a globe knowledge of the world as a whole (Stage II); which gives a proper basis for the intelligent study of the more important continents (Stage III); in which the simple geographic principles of control should be worked out; that these principles after review and enrichment should become guides for a later, more detailed study of the political, social and physical conditions of the world by continents (Stage IV); which should be summarized in a comparative review from standpoint of principles (Stage V).

This brief outline of the course as a whole may offer but little, if anything, that is new; but the newest is not always the best. The course has been planned so as not to be revolutionary, but to give the physical and social sides of the subject their due proportion of attention, and at the times in the pupil's training when the greatest good may be expected to come therefrom. The aim is to have the work of constant service to the pupils in their daily life, and to make it possible for those leaving the school at eleven or fourteen years of age to have gained from the geography work that which will aid them in their future life. At the same time the endeavor is to lay foundations for future culture that need to be laid early, though they may not bear fruit before the pupil becomes of university age.

## Stages I and II

Third grade, four periods of thirty minutes each. Fourth grade, one-third year, three periods of thirty minutes each.

### *Home Geography and the World as a Whole*

Home geography, though for a long time recognized as the logical first stage in a school course, still presents a host of unsolved problems. The scope of the subject is so large, and the possible variations of matter and method so numerous, that many teachers are at a loss what to present and what to leave until later years. In other words, the subject lacks organization. Furthermore, there is a great difference of usage as to the title home geography, so that some consider under home geography

what others would include under a study of the rest of the world. In the Horace Mann School no attempt is made to demark the fields of either division of the work. The centre of the work being the pupil, and the aim being to give the pupil an understanding of his own personal relations to the earth conditions of his immediate environment and the more distant parts of the world, there is no logical reason for dividing the course. If division is considered necessary, then it should come when the child passes from the consideration of conditions with which he or his parents come into contact daily.

HOME GEOGRAPHY. — Though it is possible to classify the topics of home geography under a few large heads, like soil, hills, mountains, valleys, drainage, air, etc., and to take up the details of each group in succession, showing the illustrations of each in the immediate environment, it does not seem wise to do so for several reasons. In the first place, a classification of a character, to be understood by the children of such a youthful age, will not stand the criticism of an expert geographer. Hence, though classification be necessary, it should not be introduced at the beginning, but rather developed as the work progresses. A larger reason for not so arranging the topics is that it tends to take away from the subject its distinct personal flavor. Home geography needs to be *home* geography in fact as well as in name. In order to secure the interest of the pupil, his life in school, at home, and during his play hours should be made the basis of the geography work. In a school course, therefore, those topics should be first introduced that influence most directly the largest number of pupils in their *out-of-school life,* for out of school is associated with play and has already given the pupil many experiences that can be advantageously used. The school-yard may be a splendid field for geography work, but it should not necessarily be the field of introduction to the subject.

Every course in home geography, therefore, must vary with the locality. On the prairies of Ohio, or the plains of Dakota, in the country districts, at least, soil is perhaps one of the most fundamental topics for consideration. This does not, however, hold true in the larger towns or in all regions. In the Horace Mann School, situated on a high hill, only approached by streets in two directions, the most pertinent topics are the slopes up which the children toil on their way to school.

The aim of the course is to make the work as personal as possible, so that every child can contribute his bit of experience to the general cause. With such a beginning it is easy to lead out to the conditions of the school vicinity, and to the conditions of the home. The life of the pupils' home, the separation of the business office from the residence, the necessity for communication, for streets, lights, sewers, gas, water, etc., are all geographical topics that can be developed gradually and successfully from such a beginning.

As the work of home geography is a natural outgrowth of the preceding nature work, so it should lead up to the next larger division of the subject. For this reason, as has already been suggested, when the more pertinent home features influencing the life of the children have been thought out and related, the expansion of the field of the subject should be outward radially until the whole world is sketched in its relation to the individual pupil. The children should lead, and those regions be studied first that they agree are the most important to them. Such a plan is not followed if the progression outward be not from the life of the children but merely from the *schoolroom* life, which is to many of them far from interesting. The ward, city, county, etc., are not important features to them at this age, and to cut off and hem in the work by such artificial lines gives wrong impressions and causes an over-emphasis of points that cannot be real to the children. The government of the city may in its simplicity, as exemplified by the police, be real, but the mayor and aldermen are not real.

The need for city government may readily be emphasized through the study of streets and lighting, for instance,[1] but the details of the mechanism of city government are complicated and remote to the child.

THE WORLD AS A WHOLE. — It is believed that the essential ideas necessary in reference to the world as a whole are its general shape, the relative position of the more important countries and continents, the life occupations and exports of the peoples, and our relation to and dependence on the whole world. The individual pupil is made the centre of the work so far as possible, and thus interest is maintained through the emphasis of personal relation.

[1] "Home Geography," by W. M. Davis, *Journal of School Geography*, Vol. I, No. 1, p. 5.

The means of communicating with and travelling to distant regions are considered in some detail, particularly the uses and geographical importance of roads, railroads, navigable rivers, oceans, lighthouses, life-saving stations, the telephone, the telegraph, post-offices, etc. Through such a study, with occasional reference to the controls that have determined the paths of the railroads, the position of lighthouses, etc., elementary ideas of the need of a central form of government can be developed. Here, as in home geography, it is the need of a government and not the form of a government that deserves emphasis.

The emphasis of the social environment at this time seems most desirable. The child is brought close to the human side at a period of development when activity and life appeal especially to him. Child-study has shown us the open door accorded to this life element, in the play and thought of the child. Through this study we are gradually learning to bring the work which we offer at this stage more into accordance with this tendency of the child mind; primarily to emphasize the life side where activity needs no interpretation; secondarily to present that which is too often looked upon as inanimate as truly living and working.

Only a beginning has been made, however, in the determination of the line of work to be pursued. The careful selection of material is of equal importance. This, then, is the next problem to be faced. In considering the social environment, what should be presented, and how should the approach be made? The needs of the child and their fulfillment suggest the answer to these questions, his interest naturally centering here. There need be no hesitation in taking advantage of this fact, for he is easily led from himself to a consideration of the agents involved in the supplying of his wants and the wants of others. This method of procedure results in revealing to the child "the world at work." He sees this, however, in and through his own domain. This does not imply that he is confined by the four walls of his home or by the boundaries of his city. It is not a far cry from one of his needs — the food upon the table — to the farmer whose labor has been a chief factor in providing it, nor to the means employed in its transfer from the farm to the home. Or again from the fuel upon which he depends to the miner who has made the satisfying of this need a possibility.

Through this study he not only realizes the labor involved

in meeting the needs of daily life, but also something of the physical conditions determining this labor. He sees his dependence upon others and the need of doing his share of the world's work. He is therefore gaining more than an introduction to the commercial and the physical aspects of geography. His interests are broadened and his sympathies deepened. He learns to think of the world as a great family and begins to feel his kinship in this family.

While this study of the home environment necessitates a departure from the immediate locality, all of the work is made to focus about the home, thus tending to strengthen the conception of New York as a great commercial centre. This is one of the aims of the plan — not only to open up the commercial side of geography through the home, but to give some idea of the greatness of this phase of life here in New York. Through personal observation in various lines some conception of the numbers of people congregated here should be formed. If this be appreciated, the necessity for sending products from far and near that the needs of this great city may be supplied will be self-evident. New York will be seen to reach out in all directions through its roads to gather in the products of the farm, the mill, the mine, etc. The importance of all the various means of transfer and communication will be apparent.

It has seemed necessary to preface this work on the more purely commercial and industrial side by a brief consideration of the local surface features. The conceptions here presented are so fundamental that they form a necessary basis for future work. It is essential that this foundation be laid at once rather than by degrees throughout the work, for by so doing many and long detours are avoided. Here, too, the human side has been kept in mind, though at times necessarily subordinated to the physical.

In passing from the home outward, those commodities in most common use are chosen as guides, and so far as time will permit, the most important exports of different selected regions are studied. As each commodity is considered, the life of the people of the country, the conditions of climate, etc., that make the commodity a possible product, and the methods of commerce are studied. In this way a causal study is made of elementary life and of the varying climatic conditions of the world. Differ-

ences of conditions become the key idea that helps us explain differences of products and life over the world, and the causal idea becomes readily prominent.

## The Course in Outline[1]

Surface features in immediate vicinity of school.
- Highlands and lowlands.
  - School and homes in relations to surface.
    (Account for location of each.)
  - Slopes and highlands.
    - Slopes followed from school to home.
    - Steepness; relation of traffic to slopes.
    - Length.
    - Direction.
      (Slopes moulded and drawn.)
  - Extent of highlands.
  - Altitude of highlands.
  - Air of highlands.
  - Altitude of lowlands compared with highlands.
  - Extent of lowlands.
  - Air of lowlands.
  - Distribution of people and lines of communication in reference to lowlands and highlands in northern New York City.
  - Beauty of lowlands as contrasted with highlands.
- Drainage.
  - Stream caused by shower.
    - Its course — account for this by relating to highland and lowland.
    - Condition and work of water.
    - Its origin.
  - Brook.
    - Work of the brook.
    - Its course.
    - Obstruction causing falls, rapids, lakes, etc.
    - Its width, volume, etc.
    - Its origin.
    - Its use.
    - Its relation to a river.
- Hills.
  - Slopes.

[1] The details here presented in reference to Stages I, II and III are very largely the work of the junior author and were originally presented in thesis form, in partial fulfillment of the requirements for the Higher Diploma of Teachers College, in 1900.

- Steepness.
- Length.
- Place of meeting.
- Varying size and shape.
- Altitude.
- Vegetation.

Valleys.
- Slopes.
  - Steepness.
  - Length.
  - Line of meeting.
- Altitude compared with hill.
- Varying size and shape of valleys.
  (Moulding and drawing.)

Life in New York City.
- Extent of city.
- Numbers of people — shown by —
  - Closely built, many-storied dwellings.
  - Crowded conveyances.
  - Great gatherings, etc.
- Streets.
  - Need of streets.
  - Great number.
  - Reason for routes followed.
  - Need of grading.
  - Need of pavements.
  - Need of sidewalks and crossings.
  - Need of light.
  - Need of sewers.
  - Need of conveyances.
- Care of city.
  - Need of street cleaners.
  - Need of police.
  - Need of fire department.
  - Advantage of city departments over individual effort.
- Railroads.
  - Need of street and steam railroads.
  - Reason for routes followed.
  - Need of grading.
  - Need of cars — varying in kind with season.
- Water routes.
  - Hudson.
    - Use as a route of travel.
    - Vessels — passenger and freight.
  - The harbor.
    - Need of a harbor.
    - Its size, depth, shape, etc.

Vessels, steam and sail; tug-boats and ferry-boats; railway transfer cars, etc.
Need of piers, etc.
Business activity in vicinity of harbor.
Lighthouses — their use, location (islands, peninsulas, etc.

Needs of daily life — how supplied in a city.
Food.
Bread.
Transportation.
From bakery.
From wholesale house.
(Need of each shown.)
From mill.
(Work of the mill considered briefly and illustrated by country grist mill.)
(Work of the farm — cultivation of wheat — harvesting, etc.)
Milk.
Transportation.
From milk depot.
From dairy farm.
Butter.
Transportation.
From store.
From wholesale house.
From creamery.
From dairy farm.
Work of the various stages shown as before.
Vegetables.
Transportation.
From store.
From markets.
From gardens.
(Need of each stage shown.)

Location of gardens observed in the consideration of the work of the gardener. Position accounted for by noticing action of water on slopes, and conditions of soil and moisture favorable for growth. Temperature required also noted. This work is based on results gained from gardening work in Nature Study in Grades I and II.[1]

Same plan followed for meat, fish, fruit and other products secured from neighboring producing regions.

Clothing.
Cotton.

[1] "Nature Study in the Horace Mann School," Elizabeth Carss and Francis E. Lloyd, this Journal, Vol. I, No. 2, March, 1900, pp. 10-16.

Transportation.
From stores.
From wholesale houses.
From factories.

Topics treated as before — former methods of manufacture (home looms, etc.) compared in brief with method of to-day.

(Cotton plantations and transportation from cotton region omitted.) Same plan followed for woolen clothing, adding one stage more, that of the sheep farm.

Fuel.
Wood.
Transportation.
From wood-yards.
From forest.
(Topics treated as before.)
Coal.
Transportation.
From coal-yards.
From mines.
(Description of a coal-mine — work of the miner.)
Homes — materials needed.
Lumber.
Transportation.
From lumber-yard.
(Distributing centre.)
From saw-mill.
(Transformation of lumber.)
From forest.
(Lumbering. Appearance of forest, life and work of lumbermen.)
(Work of each stage shown.)

Same plan for other materials used in construction — as stone, brick, etc.

In the consideration of those stages not found within the limits of the city, as the farm, mine, etc., the industry as seen in regions around New York is treated.

The need of mails, telephones, telegraph, etc., in promoting transportation is shown. Comparisons made throughout with primitive life, especially as shown in literature, in reading of Defoe's *Robinson Crusoe*.[1]

More distant regions contributing needed products to the people of New York.

[1] See "Course in English in Horace Mann School," by Franklin T. Baker, this Journal, Vol. I, No. 3, May, 1900, p. 6.

Commodities chosen with reference to illustrating interesting phases of life, extremes of life conditions, various methods of transportation and interdependence. Purpose also to give a general idea of the various continents, as to highlands, lowlands, leading cities, and to develop the globe idea of the world, and relation of its parts in direction and distance. No attempt is made to treat the details of the continents as such.

Northern North America.
- Sealskin.
  - Its use.
  - Location of region from which this product is obtained.
    (Direction from home.)
  - Seal fisheries.
- Climate — compare with weather of selected winter day.
- Plant and animal life.
- People — Eskimos.
  - Homes.
  - Habits of life.
- Transportation.
  - Methods in country.
  - Routes to New York.
    (Time required.)
    - Mountains as barriers.
      (Dwell upon idea of mountains, impressing height, slopes, difficulties of ascent, etc., comparing with local heights known. Illustrations used in abundance.)

Southern North America. (Mexico.)
- Coffee.
  - Location of region from which this product is obtained.
    (Direction from home.)
  - Coffee cultivation.
- Climate.
- Plant and animal life.
- People.
  - Homes.
  - Habits of life.
- Transportation.
  - Methods in country.
  - Routes to New York.
    (Time required.)
  - Chief port.

No special study of the United States has been planned for at this time, a sufficient working knowledge of people, of climate, etc., being gained through the work of the first stage. Principal water routes, mountains and great ports are learned in connection with transportation from the northern and southern sections of North America.

Northern South America. (Valley of Amazon.)
  India-rubber.
    Use.
    Location of region from which this product is obtained.
      (Direction from home.)
    Method of obtaining rubber.
  Climate.
  Plant and animal life.
  People.
    Homes.
    Habits of life, etc.
  Transportation.
    Methods in country.
    Routes to New York.
      (Time required.)
    Chief port.
Southern South America.
  Hides and wool.
    Location of region from which these products are obtained.
      (Direction from home.)
    Herding on the pampas.
  Climate.
  Plant and animal life.
  Transportation.
    Methods and routes as above.
    Why eastward.
    Difficulties in crossing mountains.
    Means employed.
Northern Eurasia.
  Sable — other furs.
    Location of region.
    Hunting of fur-bearing animals.
  Climate.
  Plant and animal life.
  People — Lapps, Samoides.
    Homes.
    Habits of life.
  Transportation.
    Methods in country.
    Routes to New York.
West Central Europe. (Switzerland.)
  Cheese.
    Location of region in which dairying is carried on.
    Dairy farms.
    Care of herds.
  Climate.
  Plant and animal life.
  People.

Transportation.
Methods among mountains.
Routes to New York.
(Time required.)
Scenery.
Southern Europe. (France and Spain.)
Wine.
Location of grape-growing region.
Vineyards.
Climate.
Plant and animal life.
People.
Transportation.
Methods in countries studied.
Routes to New York.
Chief port.
Southeastern Asia.
Tea.
Region from which obtained.
Tea culture.
Climate.
Plant and animal life.
People (Chinese).
Homes.
Customs.
Habits of life.
Transportation.
Between India and China.
Why principally by water.
Means of transportation over mountains.
Routes to New York.
Chief ports.
Central Africa.
Ivory.
Its use.
Region from which obtained.
Method of securing it.
Climate.
Plant and animal life.
People.
Homes.
Habits of life.
Transportation.
To coast (caravans).
Routes to New York.
South Africa.
Diamonds.
Location of diamond fields.

Diamond mining.
Climate.
Plant and animal life.
People.
Transportation.
Method in country.
Routes to New York.

From the continual use of globes throughout the work, the shape of the earth, the position of the great land and water masses, the warm, temperate and cold regions should have been seen.

By a gathering and placing of facts learned through the study of individual countries, the heat belts of the globe will be readily located, as well as the plant and animal life common to these belts.

Globe.
Summarized as to form (simple proofs), size, position of land and water masses. (See course in English, *loc. cit.*, p. 7.)
Grouping of countries studied climatically.
Heat belts.
Reason for differences seen.
(Simplest conceptions only given.)
Grouping of plant and animal life.
Rotation.

Idea of map developed toward the close of this stage. Need of a scale shown and the *use* of the parallels of latitude and meridians of longitude.

Throughout this work show the effect of the telegraph, mails, cables, etc., upon commerce. Compare advantages of the present with past conditions.

## Related Observational Work

It is expected that the pupils entering upon a study of geography in the third year of school will have studied the following points in the earlier years:

*Direction and Distance.* — Cardinal and semi-cardinal points of compass; relative position of familiar objects. Distance in feet, yards, etc. Size.

*Non-Instrumental Weather Observation and Records,* at certain seasons, including,
Character of day, i.e., clear, fair, cloudy, stormy.
Direction and strength of wind.
Temperature, i.e., warm, cool or cold.

Precipitation, as snow (coarse or fine), rain (heavy or gentle), fog, etc.

Beginning with Stage I and continuing through Stage III, a course in observational geography is conducted parallel with the systematic course outlined. The work planned is progressive, and related to other work in geography and nature study. Through both lines of work a basis is laid for the elaboration and enrichment of the principles of physical geography in Stage IV. The following is outlined for Stages I and II.

Non-instrumental observations to bring out relations among weather elements. Study to occupy several scattered periods, as October, December, March, May, during year, so as to illustrate seasonal variations of weather.

*Winds.*

Direction and velocity (classify as calm, light, moderate, strong, gale).

Relation to temperatures.

Relation to character of day, and precipitation.

*Sunshine Chart.*

Orange — fair.
Yellow — clear.
Light gray — cloudy.
Dark gray — rainy.
White — snow.

} At end of each period find number of sunshiny days, cloudy days, stormy days, etc.

OBSERVATIONAL WORK, PARALLEL TO LATER PORTION OF STAGE II

*Sunshine and Temperature.* — Dry bulb thermometer to be used.

Position of sun in the morning — window receiving sunlight.

Position of sun at noon. Passage from eastern to western part of sky.

Position of sun in afternoon — window receiving sunlight.

Direction of shadow in morning, at noon, in afternoon.

Difference in intensity of light in the early morning, at noon, in late afternoon. Reason.

Length of shadow cast by a vertical rod measured at different periods throughout the day. Time of longest and shortest shadow noted. Time determined from length of shadow. Daily temperature in relation to length of shadow at cer-

tain hour each week noted. Relation between length of shadow and temperature. Reason for change in shadow length.

*Moon.*

Position of new moon. Direction of horns; direction of horns of old moon.

Position of moon at time of first quarter, full moon, and last quarter.

Account for changes in appearance of moon.

## Stage III

Fourth grade, two-thirds of year, three periods of thirty minutes each. Fifth grade, three periods of thirty-five minutes each.

### *The More Important Continents from Standpoint of Industrial Life*

Among the difficult problems that confront a teacher entering with his class upon an elementary study of a continent, is that of avoiding pure memoriter work, and yet at the same time securing a good acquaintance with certain fundamental facts that must be at ready service if any causal study is to be undertaken. A certain knowledge of the general climatic position of a continent is absolutely essential at the beginning, and yet such a knowledge cannot be developed as fully as is desired by the beginning of the fourth year. Hence certain fundamental facts in reference to heat belts must be early taught without developing the ideas. No more should be taught than is necessary for immediate use, and the delay should not be long on such details. The plan of teaching such facts advocated here may not be pedagogically strong; but the effectiveness of the later work is so much increased by such a beginning that the break in method needs no apology.

In a similar way a teacher finds it necessary to drill his class in visualizing the location of many places in the United States, that cannot be located causally. To secure a working acquaintance with the necessary details of location in the United States by development would be so time-consuming as to be absurd: to neglect to secure such an acquaintance would bring down upon

us the well-earned condemnation of the parents who demand, and rightfully, that their children shall know their own country, at least sufficiently well to understand the whereabouts of the principal events chronicled in the daily press.

As has already been suggested, the point of view in the early treatment of North America is that of industrial centres. By a study of the leading industrial centres of the United States, and their relation through commerce, it is possible not only to make the life side of geography prominent, but also to develop a need in the pupil's mind for a better knowledge of the physical causes of such great consequences. The teaching of North America from the standpoint of industrial centres does not, however, mean an emphasis of technical details of industry, which are neither earth-determined nor earth-influenced except in a very remote way.

The geographical phases of industries that to the author seem legitimate parts of school work are mainly their distribution and general character, when these have been in part, at least, determined by the setting in which they flourish. For instance, it is the presence of coal and iron in the neighboring region that makes Pittsburg, Pa., an iron-smelting city; but it is the ingenuity of man, and not the presence of coal and iron that has determined the technical details of iron or steel making. Again, it is the presence of natural water power that makes possible such large manufacturing places as Holyoke, Mass., noted for its paper-mills, or Manchester, N. H., with its world-famous cotton mills; but the geographical conditions have determined only the possibility of manufacturing by water power, not the character of the industry. In the same way certain agricultural areas are determined in their place by the combined occurrence of suitable soil and climate, and the kind of agriculture may to a large degree be determined by nearness to a market. The technique of raising cotton, celery, or Indian corn is not, however, except in the most remote sense, geographically determined.

Not only are industries on the whole not earth-determined and hence not to be considered logically a part of geography for school purposes, but there are several other reasons why such details should not be included in school work. In the first place, the details of a complicated industry, such as the making of fine bolted flour, or the refining of gold, are not easily understood

even by the average adult, and a visit to a mill or a refinery leaves no clear images, but general conceptions only. Such conceptions are not as clear cut and accurate as the conceptions in school geography work ought to be, in spite of the fact that the adult has a better power of seeing the essentials, and a better mental basis for understanding the processes than any school pupil could have. Such conceptions are of little permanent value, of but small relative value, and surely the whole field of geography offers scores of large subjects more capable of giving knowledge of greater present and future value, and more mental power. Such details are for the technical schools or the business training of later years, and should not take up time that could and should be devoted to more pertinent and valuable work.

Again, a detailed knowledge of any industry, however interesting, is not necessary to a child in his every-day life. Exception may be suggested in the case of those industries that furnish occupation to a child's parents. Yet further thought will show that in most cases these are just the industries concerning which the child in most cases needs no training; long familiarity with them has given him a first-hand knowledge, that never could be gained from books and excursions, and a study of such industries would not only be a waste of time, but a bore to the pupils.

Therefore, inasmuch as technical details of industries are not necessary to the pupil, not easily illustrated to him, or understood by him, and of but little permanent or relative value, there seems no adequate reason for devoting to them the large amount of time sometimes given.

This does not mean, however, that the industrial side of life should be neglected or omitted. This would be a serious mistake, for the introduction to earth causes in the elementary grades must be through the study of life consequences, and particularly those consequences with which the child is most familiar. Industries furnish the very best possible introduction to the study of human geography, but too great elaboration of details detracts from the geographical value of the subjects, and places the emphasis of the work on the ungeographic details, which are not necessary from the standpoint of clearness. A child does not need to study plows and harrows in order to understand the necessity of making soil fine and loose for successful farming any more than he needs

to know the detailed working of a shoe sewing machine as a basis for understanding that manufacturing consists in turning raw products into finished goods.

What a pupil does need to know in reference to an industry is what is done, and the geographical conditions that make the industry possible. Whether the farmer shall raise wheat or potatoes or corn is not of such importance as are the conditions that make agriculture possible at all. Only when the conditions particularly favor some special form of agriculture should emphasis be laid on that form, and even then the only details that should be studied are those that determine the habits and customs of the peoples in a large way.

The geographical conditions, then, that are essential to the successful carrying on of an industry are the facts to be developed through industry, together with those social conditions that are the results of the attempt to carry on the special line of work. The great groups of industry that stand out most strongly as objects for study are agriculture, grazing — including dairying, lumbering, hunting and fishing, manufacturing, and commerce. Each of these groups may be illustrated by many varieties, depending, perhaps, on local or special conditions, but in each variety there are certain fundamental ideas common to the group as a whole. The geography teacher's task, therefore, is to develop an idea of the geographical conditions that determine the whole group, more than the special form which is used for illustration. At least such is the task in the elementary work where the causes are being developed. In the advanced work, where life consequences are, or should be, studied as results of physical causes, it is possible to go into details and to illustrate the intimate relations of detailed conditions to minor causes. For instance, in the elementary grades, the study of what makes manufacturing possible in New England, lays a basis for developing a more complete knowledge of the essentials of manufacturing. In the upper grades, the influence of climate in determining the manufacturing of certain special kinds of cloth in New England may be brought out. Such a matter, however, would be too special for the elementary work.

Geographical Elements in Industries. — Such being the field of work and the point of view that seem best adapted to lower or intermediate grade work, let us see what are the essential

geographical elements underlying each of the great groups of industries.

AGRICULTURE. — The four geographical essentials of agriculture are a slope suitable to hold the soil that is formed, good soil, a favorable climate, and accessibility to markets. Given these conditions in an occupied country and agriculture thrives. The essentials of agriculture are not to be found best shown in large farms where there are all the modern conveniences in the way of improved machinery, wind-mills, fertilizers, etc., but in the small farms of certain parts of New England, for instance, where the ground is tilled in a most simple way. Of course in this case and in the topics which follow, any generalization as to the essentials must be worked out from several instances, taken from different parts of the country; but the work fails unless the generalizations are made, and so clearly developed that they are a sound basis for later work.

GRAZING AND LUMBERING. — Practically the same conditions pertain here as in agriculture, but in different aspects. Grazing can be carried on on steeper slopes and poorer soil than agriculture, and accessibility to market is not an important factor, except in certain forms of dairying. Slopes so steep or inaccessible as not to be needed for grazing are apt to be devoted to forests; but the three industries are closely related, and their occurrence is largely due to geographical conditions. (See also Course in Nature Study, *loc. cit.*, p. 21.)

MANUFACTURING. — Manufacturing depends on the availability of raw material, perhaps occurring as products to be secured directly from the earth, the presence of power in some form, and again the accessibility to markets. The best place to see the geographical significance in the location of this form of industry is not in some large cotton mill, with its noise and movement, even though the power be water, but preferably in some country grist mill, where the water can be seen setting the grinding stones in motion, and where the whole process of changing unground corn to meal ready for use can be seen without any complications. In such a case the importance that natural power plays is readily emphasized.

MINING. — In the group of industries included under the head of mining, we have one of the best illustrations of geographical control, inasmuch as mining, including quarrying, is con-

cerned entirely with securing from the soil and rocks of the earth natural products of economic value. Therefore all forms of mining are determined in their position by geographical conditions, and the importance of those conditions can be easily made clear.

FISHING AND HUNTING. — Fishing and hunting centres are well determined in their location by their geographical position. It is a good harbor, favorably located for easy access to fishing grounds that determines the success of a fishing town, and hunting for a livelihood is largely confined to those parts of a country having climatic conditions not permitting successful permanent residence. (See also Course in Nature Study, *loc. cit.*, pp. 20 and 22-23.)

COMMERCE. — In order to be a good centre for trade a town must be so situated that it can secure a large amount of goods to be sold with the least cost of transportation from the place of production or manufacture. It must also have a ready means for sending the goods away to other cities or other countries, at small cost and little delay. Thus a commercial town is determined in its location by several factors that are geographical, the more important of which can be easily illustrated and emphasized in almost any direction.

SCENIC CENTRES. — There are a number of thickly occupied regions in the United States, to which people have been attracted by the scenic conditions that make such places attractive to travellers and pleasure seekers. The caring for such visitors as go to such a scenic centre as the Yellowstone National Park can hardly be called an industry, but it is an occupation determined in its location by the features of a geographic nature that make the Park famous. In most regions that may be grouped under this head the features that attract both visitors and permanent residents are geographic, so that the centres are geographically determined.

In any case the best illustration of an industry is not one where there is the greatest complication, but that in which the fundamental conditions stand out most clearly and with the least complexity. When the essential conditions of any centre have been brought to a focus through the inductive study of several uncomplicated instances the more complicated instances, in which the fundamentals are obscured, may be studied as varieties of a general case.

Thus it is possible to classify the instances, not according to size and supposed importance, but according to a classification based on causal conditions.

It is in this way that industries are studied in the Horace Mann School, somewhat fully, but not technically, and yet in such a way that the geographical side is emphasized. At the same time the life or human side is made the basis of the work in the lower grades, thereby emphasizing the aspect of the whole field of geography that is to most pupils of elementary school age of the greatest interest.

It is believed that the plan outlined enables the teacher to make the strongest use of " types," the typical case being in many instances, however, developed as a composite rather than exemplified by a complicated and striking example. Such a use of the idea of types corresponds with the meaning of types as used by working scientists.

The course outlined in the rough follows. Each area or centre is located as it is treated, routes of transportation are followed on a map and much training is given in visualizing locations, but as far as possible causally. At the end of the fourth year the pupils have gained a good working knowledge of the United States, and further they do not see the country in pieces, but as a whole, with intimately related parts.

*North America*

Agricultural Sections. — Cotton.
- Cotton belt (of United States).
  - Slope, soil, temperature, rainfall.
  - A cotton plantation.
    - Extent.
    - Life.
  - Varieties of cotton.
    - Inland.
    - Sea Island.
      - (Other cotton sections noted.)
  - Cotton centres.
    - New Orleans.
    - Galveston.
    - Savannah.
    - Charleston.
  - Reasons for these locations.
    - Location in regard to cotton region.
    - Ease of transportation.

Manufacturing Sections.
  Destination of raw product.
  Reason for this.
    Water power.
    Ease of transportation.
    Country unsuited to agriculture.
    Nearness to centres demanding finished products, etc.
  Transportation.
    From cotton section to manufacturing region.
    Greatest New England port.
    From port to manufacturing centres — Fall River, Lowell, etc.
      (Account for location.)
    Distribution of finished products.
      To various parts of the United States.
      To foreign countries.
Agricultural Sections. — Wheat, Sugar-cane, etc.
  Wheat producing areas. (Great Region of the United States.)
    Slope, soil, temperature, rainfall. (Compare with cotton section.)
    Wheat fields.
      Extent.
        (Other wheat sections noted and compared.)
    Great wheat shipping and milling centres. (Reasons for this.)
      St. Paul.
      Minneapolis.
      Milwaukee.
      Chicago.
      St. Louis.
      Winnipeg.
      Montreal.
      Quebec.
      (One centre studied in sufficient detail for clearness — others compared with it.)
    Transportation.
      Routes by which grain and flour are transported, water and rail.
      Ports from which shipped.
      Foreign countries dependent upon our wheat fields.
  Sugar-cane region (United States).
    Slope, soil, temperature, rainfall. (Compare with wheat and cotton sections.)
    A sugar plantation.
      Extent.
      Life.
        (Other sugar-cane sections in North America compared.)

Great sugar ports.
Havana.
New Orleans.
Destination of raw products.
Brooklyn.
Philadelphia.
Boston, etc.
Transportation.
From region raising product to centres refining it.
Distribution of finished product.
Corn, oats, fruits, tobacco, treated as preceding topics.
(Density of population as dependent upon productive regions shown.)
Grazing Sections.
Cattle.
(Great Plains. — Slope, soil, temperature, rainfall. Compare with sections studied.)
Ranch.
Extent.
Life of cowboys.
(Compare with herding on the pampas.)
(Other grazing sections of North America noted.)
Dressed-beef centres.
Chicago.
Kansas City.
Transportation.
Shipping of cattle from producing areas. Routes traversed.
Routes of distribution of beef products to various parts of the United States and abroad.
Routes by which hides are sent to New England, Pennsylvania, etc. — Ports receiving raw material. — Manufacturing centres. — Distribution of finished products.
Dairying.
(Prairies. — Slope, soil, climate.)
Compare with dairying seen in vicinity of home locality.
(Other regions in which dairying is carried on noted.)
Centres of dairying regions — Utica, Des Moines, etc.
Transportation of dairy products.
Sheep.
(Great Plains.)
Ranch.
Size.
Life.
(Other sheep raising sections noted.)
Sheep and wool markets.
Galveston.

San Francisco.
Cheyenne.
Fort Worth.
Cincinnati.
Transportation of wool.
Routes to New England, New York, etc.
Ports receiving raw material.
Manufacturing centres — Philadelphia, New York, Lawrence, etc.
Distribution of finished products.
Lumbering Sections. (Northern United States.)
Slope, soil, temperature, rainfall.
(Compare with other sections studied.)
Appearance of region.
Lumber camp. — Compare with lumbering seen in vicinity of New York. (See Nature Study Course, *loc. cit.*, p. 21.)
(Other forest regions of North America compared.)
Differences in lumber grown in various sections.
Uses.
Lumber centres.
Chicago.
Minneapolis.
San Francisco.
Bangor.
Quebec.
Toronto.
(One centre studied in sufficient detail for clearness, others compared.)
Transportation.
Distribution in country.
From the United States.
To the United States.
Mining Regions.
Coal. (Appalachian Mountains.)
Extent of fields.
Coal beds.
Size of mines.
(Other coal fields compared.)
Centres of coal trade.
Chicago.
Philadelphia.
Pittsburg.
Erie.
St. Louis.
Buffalo, etc.
Reasons for the centres.
Location with reference to coal fields.
With reference to ease of transportation.

Effect of coal supply upon centres.
Transportation.
Routes by which coal is sent to centres.
Routes of distribution.
Iron. (Appalachian Mountains.)
Extent of iron fields.
Iron mining.
Compare with coal mining.
(Other iron regions noted and compared.)
Relation between iron mining region and coal mining.
Iron manufacturing centres.
Chicago.
Philadelphia.
Pittsburg, etc.
Reason for this industry in these cities.
Transportation.
From iron regions to centres.
Distribution of finished products.
Petroleum.
Extent of oil fields.
How petroleum is obtained.
Centres refining it.
Cleveland.
Philadelphia.
Transportation.
Modes of transportation from oil fields to centres refining it.
Distribution to various parts of the United States and abroad.
(Same plan for gold, silver, copper, and building stones.)
Fisheries.
Newfoundland "Banks."
Location in regard to continent.
Heat belt.
Extent.
Fishing voyages. (See Nature Study Course, *loc. cit.*, p. 22.)
(Compare with conditions found off coast of Norway.)
Other fisheries of North America noted and compared.
Centres of fish trade and manufacture.
Baltimore.
Gloucester.
Seattle.
Halifax.
St. Johns.
Victoria.
Transportation.
Routes by which fish reach these centres.
Routes of distribution.

Commercial Centres.
  Position of New York City studied in detail, noting:
    Its nearness to sources of supply.
    The extent of country on which it can draw, etc.
    Its facilities for transportation.
    Its relation to European ports.
  Compare other great commercial centres.
    San Francisco.
    Chicago.
    Boston.
    New Orleans.
    Philadelphia, with New York in these respects, noting advantages of each.
Scenic Centres.
  Adirondacks.
    Extent of region.
    Appearance.
      Height of mountains.
      Immensity of forests.
      Mountain lakes.
      Winding streams.
    Life in the woods.
      Trails.
      Camps.
      Hunting, fishing, canoeing, etc. (See course in Nature Study, *loc. cit.*, p. 20.)
    Value of such regions.
      For growing in sympathy with nature.
      For restoration of health.
      For rest to be found.
      For recreation.

In a similar manner study such centres as the White Mountains, Catskills, Atlantic City, Niagara Falls, Yellowstone Park, Canyon of Colorado, Los Angeles, etc.

### Observational Work Parallel to Earlier Portion of Stage III

Forms of Moisture.
  Explain that evaporation takes place from ponds, lakes, rivers, oceans, etc. Impress the thought of the great amount of moisture carried up daily.
  Invisible moisture.
  Visible. — Transformation of vapor into clouds.
    Classes of clouds.
      Cirrus, stratus, cumulus, nimbus.
    Note appearance, altitude, and formation of each class, also

weather conditions or time of day with which each is associated.
Direction and rapidity of movement observed.
Fog.
Formation. — Compare with cloud formation.
Effect of sun upon fog.
Rain.
Shape and size of drops. Amount of precipitation measured after a storm.
Work of rain.
Snow.
Flakes. — Shapes, sizes, formation, crystallization of salt, sugar, etc., observed.
Snowfall measured. — Use of snow.
Hail.
Shape and size of hailstones.
Formation.
Effects.
Dew.
Appearance of grassy field in early morning recalled; later in day.
Formation of dew.
Chill pitcher of water in room. — Allow it to grow warm. — Formation and disappearance of dew noted.
Effect of clouds upon formation of dew. — Effect of winds.
Formation of dew on mountain summits and in valleys compared.
Frost.
Its formation.
Protection of vegetation against frost.
Its work.

Sun.
Review work of preceding stage on the relation of the earth to the sun.
Note when sun rises and sets exactly in east and west. (Length of day and night at this time.)
Variation from these points according to season.
Slant of sun's rays measured at various periods throughout the year. — Variations noted and explained.
Angle compared with length of day and with temperature.

### *Eurasia*

Eurasia is studied in the fifth grade from the same standpoint as North America in the fourth grade, so that by the close of the work of Stage III the pupils have received a good founda-

tion for the emphasis of physical controls that is to come in later stages. Through the constant comparisons and relations that are emphasized between the new work and that which has preceded, a good perspective is given, and a knowledge of location is gained by the pupils almost unconsciously. As an aid in visualizing relative positions all the leading centres, the principal trade routes, and towns are filled in on blank outline maps by the pupils. The method is such that the pupils' knowledge is continually being used, so that reviews are constant, and the continued emphasis of life conditions keeps the class easily and sanely interested in the work. Parallel with the continental work is a series of exercises in observational geography that is aimed to give training in observation, and to help lay a foundation in knowledge for a later, more appreciative study of certain phases of physical geography. This work is much assisted by a portion of the Nature Study work of the grade, which is devoted to Heat. (See Course in Nature Study, *loc. cit.*, pp. 24-28.)

The history work for the grade is the ancient history of Greece and Rome, making it possible to have the history help the geography, and the geography help the history to an equal degree. Much time can be saved in each subject by the method followed.

Position.
  Direction from United States.
  Latitude and longitude.
Climate.
  Heat belts.
    Compare with North America.
  Winds.
    Direction.
    Influence upon temperature.
  Rainfall.
    Effect of mountains upon rainfall. Compare coast and interior of Scandinavia, of Spain, of India, etc.
Agricultural sections.
  Recall conditions found favorable for agriculture in North America.
    From a study of maps select regions which are adapted to agriculture in regard to
      Slope.
      Soil.
      Temperature.
      Rainfall.

Study the tundras, desert regions, etc., noting conditions which are lacking, effect upon plant life, animal life, and man.

Selection of regions in which essentials for agriculture are found.

Northern lowland, from Atlantic through Southern Russia and Southern Siberia.

Valleys of Danube, Po, Rhone, etc.

Southern Europe.

Asia Minor, China, Japan, Korea, India, etc.

(Note differences in climatic conditions. — Differences in products to be expected.)

Wheat.

Recall conditions favorable for growth of wheat in North America.

Probable location of wheat fields.

Countries in which essential conditions are found:

Russia (black earth region), Austria-Hungary, Balkan States, France, Germany, Denmark, England, India, etc.

Compare latitude of sections studied with latitude of wheat-growing section in America. Note variations in climate and topography in sections studied. — Effect upon crops. — Conditions most favorable for growth of wheat.

Comparisons of amount of wheat raised in Eurasia and North America; in Russia and remainder of Eurasia. Comparisons of population (as a result of these comparisons show that in general wheat must be bought by Western Europe, — sold by United States and Russia).

Wheat markets.

Odessa, Bombay, Budapest, Danzig, St. Petersburg, etc.

Account for above.

Location in regard to wheat regions.

Ease of transportation.

Routes of transportation.

From wheat sections to ports.

From ports to various parts of the world.

(From study of physical maps decide upon probable routes of exportation, verifying conclusions from commercial maps. — Note seas, rivers, canals, chief railroads, etc. Compare advantages of Northern and Southern ports.)

Flax.

Nature of flax. — Its use.

Conditions favorable for growth in regard to slope, soil, temperature, rainfall.

Where found.

Ireland, Belgium, Netherlands, France, Germany, Austria, Italy, Russia, etc.
Cultivation of flax.
Compare production of Eurasia with that of North America. — Reason for difference.
Flax area compared in extent with cotton section of the United States.
Centres of manufacture and exportation:
Belfast, Ghent, Riga, St. Petersburg, Lille, etc.
Account for above.
Location in regard to flax districts.
In regard to mining regions.
In regard to ease of transportation, etc.
Routes of transportation as before.

Mulberry.
Reasons for cultivation.
Conditions favorable for growth.
Where found.
France, Italy, Japan, China, India, etc.
Cultivation of mulberry.
Range of climate.
Compare extent of cultivation with that of United States.
Reasons for difference.
Centres of manufacture and export.
Lyons, Havre, Marseilles, Krefeld, Milan, Shanghai, Canton, Tokyo, Yokohama, etc.
Reasons for centres.
Vicinity to mulberry region.
Facilities for manufacture.
Ease of transportation, etc.
Routes of transportation.
From Japan to United States; Italy to Germany, — to Switzerland; France to United States; China to Great Britain, etc.
(Physical and commercial maps used as above.)

Grapes.
Value of the vine.
Conditions essential for growth.
Where found.
France, Germany, Italy, Spain, Austria-Hungary, etc.
Vineyards.
Their location. — Why southern slopes are preferred.
Description of vineyards. — Life in connection.
Centres of manufacture and exportation.
Cadiz, Lisbon, Oporto, Bordeaux, Malaga, Marseilles, Cologne, Vienna, etc.
Reasons for above.
Routes as before.

(Same plan for rye, sugar-beet, hops, tea, etc.)

Grazing.
- Recall conditions found favorable for grazing in North America.
- Location of grazing regions of Eurasia.
  - Among Alps. — Other highland regions.
  - Through British Isles, Netherlands, Plains of Hungary, Southern Russia, Southern Siberia.
  - Portions of Asiatic Turkey, Arabia, Persia, Afghanistan, Beluchistan, etc.
- Grazing among Alps and occupations dependent recalled.
  - Compare with grazing in North America.
- Grazing in Holland studied, noting:
  - Conditions under which it is carried on, — elevation, slope, etc. Comparison with conditions observed among Alps, — with grazing regions of North America.
  - Life in connection compared with life among Alps, — with life of Western plains.

(Other grazing regions of Europe noted.)
- Grazing products of Europe.
- European centres of manufacture and exportation.
  - Rotterdam, Cork, Copenhagen, Budapest, Odessa, Ghent, Brussels, Leeds, Elberfeld, etc. Show industry of towns to be dependent upon
    - Accessibility of raw products.
    - Vicinity to markets demanding products.
    - Ease of transportation, etc.

(Show advantage of accessibility of coal and iron.)
- European routes of transportation.
- Grazing in Asiatic Turkey, Arabia, Persia, Afghanistan, Beluchistan, compared with regions studied, noting:
  - Climatic conditions.
  - Slope, soil.
  - Herds.
  - Life in connection.
- Grazing products of Asia compared with those of Europe.
- Asiatic centres of exportation and manufacture.
  - Smyrna, Bagdad, Mecca, etc.
- Account for Asiatic centres.
- Manufacturing of carpets, shawls, etc., compared with manufacturing in sections previously studied.
- Asiatic routes of transportation. — Methods.

Lumbering.
- Conditions found favorable for lumbering in North America.
- Location of lumbering regions.
  - Forest belt of Northern Eurasia.
  - Highlands of Southern Europe.
  - Central India, Siam, etc.

Forest belt of Northern Eurasia studied in detail, noting:
Extent of region.
Slope, soil, climate.
Kinds of wood.
Uses.
(Compare with lumbering in North America.)
Other lumber sections compared.
Lumber centres.
St. Petersburg, Riga, Christiania, Gothenburg, Archangel, Bombay, Rangoon, etc.
Account for industry of centres studied.
Routes of transportation.

Mining.
Regions generally adapted to mining in North America.
Probable location of mining in Eurasia.
Regions in which coal and iron are found.
Great Britain, Germany, Belgium, France, Ural Mountains, other highland regions, China, Japan, etc.
Special study of those districts combining coal and iron, noting:
Richness of deposits.
Productiveness. — Compare with United States. — Compare Great Britain and China. — Account for difference. — Effect upon industries of countries.
Advantage arising from the combination of coal and iron.
Facilities for transportation.
Centres of export and manufacture.
Glasgow, Manchester, Birmingham, Cardiff, Liverpool, London, Hamburg, etc.
Account for special industries of centres, e.g.:
Glasgow. — Iron steamships.
Vicinity to coal and iron.
Vicinity to sea.
Manchester. — Cotton.
Vicinity to coal and iron.
Vicinity to port receiving raw cotton.
Ease of transportation, etc.
Brussels. — Carpets.
Vicinity to flax region.
Vicinity to wool-growing section.
Vicinity to coal and iron.
Ease of transportation, etc.
Routes of transportation.
From coal and iron sections to manufacturing centres.
From manufacturing centres to ports.
From ports to various parts of the world.
(Same plan for petroleum, copper, gold, etc.)

Fishing.
  Conditions found essential in North America.
  Probable location of fishing banks.
  Fishing areas.
    Northwest coast of Eurasia.
    Southwest coast of Eurasia.
    Mediterranean.
    North Sea.
    North Pacific.
  Study each section, noting:
    Depth of water.
    Heat belt.
    Kind of fish. — Mode of fishing.
    Extent of shoals, etc.
      (Comparison with Newfoundland Banks.)
  Centres of fish trade.
    Bergen, Bordeaux, London, Hull, etc.
  Reasons for centres.
  Routes of transportation.
Summarize preceding topics by a study of commercial centres.
  Study centres as London, Liverpool, Manchester, Glasgow, Hamburg, Berlin, Cologne, Havre, Lyons, Paris, St. Petersburg, Vienna, Bombay, Calcutta, Canton, Peking, Tokyo, etc., noting:
    Size.
    Location. — Relation between size and location.
    Special industries.
    Relation to other great centres.
    Facilities for obtaining raw products, — for exporting finished products, etc.
      (In each centre studied bring together the elements which have combined to make the centre an important one.)
Scenic Centres.
  Regions visited by tourists.
    Alps.
    Mountains of Norway.
    Mount Vesuvius.
    Venice.
    The Rhine, etc.
  The Rhine.
    Its source. — Fed by glaciers.
    Its length.
    Character of stream.
      Upper Rhine.
      Middle Rhine.
      Lower Rhine.
        Each portion fully described, noting:
          Width and volume of stream. — Lakes, rapids, falls.

— Banks, their height. — Forested areas along stream. — Vineyards. — Ruins, etc.
Position of the Rhine as a scenic centre.
Comparison with Hudson.
(Other scenic centres studied in a similar manner.)

### Observational Work Parallel to Later Portions of Stage III

Continue observational work on sun's position in sky as noted for earlier portion of Stage III.

Choose a month in fall, winter, early spring, late spring, noting phenomena connected with the season, accounting for same, i.e.:
December.
Short days. — Their length.
Long nights. — Their length.
Length of noon shadow.
Limit of sunshine.
Low temperature.
Kind of precipitation, etc.
Moon.
Time of rising of moon. — Time of rising as moon grows old. — Reason.
Reason for change in appearance of moon. (Position in regard to earth and sun explained.)

### Stage IV

Sixth grade, three periods of forty minutes each; seventh grade, three periods of thirty-five minutes each.

As will be readily seen by those who have followed the course thus far outlined, increasing emphasis has constantly been laid upon the importance of the physical side in geography. In Stage III our aim was to introduce the pupil gradually to the real importance of physical controls in determining or influencing life conditions, so that he would be prepared to take up the study of these topics as worthy of special treatment. In Stage IV the topics in reference to climate, latitude, longitude, etc., that have been touched upon, especially in the observational work and in the related Nature Study of Stages II and III, are brought together, related, reviewed, and strengthened, with a view to using the generalizations thus developed in a

study of the more important continents from the physical standpoint.

All the physical controls that will be used in the later work of Stage IV are not, however, considered in detail before being applied to some particular continent. Those elements of climate and of mathematical geography touched upon in the earlier stages that are fundamental in a causal study of any continent are first taken up. They are then applied to the study of Africa. The other physical features such as land forms, ocean currents, etc., whose effects are better seen in detail than in general, are considered as need for them arises. Thus by the time Africa has been covered fully, the class are ready to take up the later continents entirely from the physical standpoint, outlining at once the several broad features of position, climate, topography, etc., that are of importance in determining general conditions. They can then pass to special conditions as largely the result of local physical conditions with understanding and profit.

This method, when properly put in operation, demands a use of physical geography that renders it unnecessary to have a special course in physical geography in the earlier high school years. Many facts must, of course, be omitted that might be included in a first year high school course; but all the necessary physical controls of life may be studied scientifically and thoroughly, and made permanently of value through being applied and used in every-day school work, so that the scientific study of physical geography as such may be deferred until the later years of the secondary schools. Such a plan, furthermore, allows the best ideas in reference to geography teaching to be woven together in such a way as to prevent one-sidedness, while ensuring good, thought-provoking work that is of practical, every-day value, and, further, that lays the foundation for later, better work. With such a plan, neither the physical geographer, the commercial geographer, nor the sociologist can rightfully claim that the pertinent facts of his field have been neglected until the children are dulled to their beauty and importance.

The working out of a course of study so that the attention given physical geography shall gradually be increased in amount and in significance as the years advance is not an easy task. From the whole field of physical geography there must be selected those facts that are of the greatest value; these facts must

be arranged so that progress is assured without over-repetition, and must be related to the conditions of which they are the causes so that the knowledge of both causes and consequences is enriched through such a causal study.

The history work in Grade VI is mediæval history up to the age of discovery, which is naturally based on the geography work of Stage III. The Nature Study work of the sixth grade is in part devoted to the properties of air, which is of especial value in assisting the study of climate. (See Course in Nature Study, *loc. cit.*, pp. 33-35.) In fact, the work of the two courses in this particular cannot be separated. It might with equal propriety be called all Nature Study or all Geography.

The Nature Study work of Grade VII is in part devoted to the distribution of plants. (See Course in Nature Study, *loc. cit.*, pp. 37-38.) This work is based directly on the facts of climate and topography already acquired in the geography course, and at the same time assists the geography work in bringing out from a biological standpoint the effects of the physical environment that must be considered in geography work largely from the physical or earth standpoint.

The history work of the grade and of the last grade of the elementary school being entirely American history, is directly based on the geography of North America and especially that of the United States. In fact, during a part of the seventh grade, the work in these two subjects can go hand in hand, and in treating the geography of the different physical regions of North America those divisions are taken up in the order that best aids the study of colonial history.

## The Course in Outline

Direction and Distance.
- Compass points in schoolroom: north and south line.
- Development of meaning and use of latitude based on observations of previous grades continued in this grade.
- Development of meaning and use of longitude and time in a similar way. — Standard time.
- Measurement of distance by degrees of latitude and longitude.

Area and representation of area.
- Plans and maps.
- Study of scales of representation.
- Meaning and use of common maps continued. Map of schoolroom to several scales.

Weather.
  Weather conditions in New York.
    Wind and temperature at different seasons.
    Wind and rainfall at different seasons.
    Relation of cloudiness and fair weather to winds and temperature.
    Study of weather elements of selected days that illustrate weather of other climatic belts.
    Study of average weather conditions for a month, based on class and individual observations.
    Representation of weather on weather maps.[1]
    Study of weather maps for wind, temperature, and isotherms.
Climate.
  Study of the distribution and climatic features of great wind belts of world, based on study of form and motions of world, which is in part developed from observational work of previous grades. Work to be in part an outgrowth of study of Africa (see below). (See also Course on Nature Study, *loc. cit.*, pp. 33-35).
  Distribution of greater land masses of world in reference to wind systems. Comparison of several wind belts, and of land and water portions of each.

## *Africa*

Location of Africa in direction from schoolroom; in latitude and longitude. How would we go from New York to Algiers. To Cape Town? Shape and size of Africa; map representation of Africa.
Climate.
  Distribution of temperature in summer and winter as shown by isotherms.
  Annual range of temperature — in Congo basin, at Cairo, at Cape Town.
  Preliminary.
    Division of Africa into habitable zones according to temperature.[2]

[1] The blank weather maps used can be obtained from the United States Weather Bureau for a very small sum, approximately $1.55 per 1000. These maps are also of great service for use as outline maps in the study of the general geography of the United States.

[2] Throughout the continental work extensive use is made of outline maps in representing the distribution of different phenomena. Thus training is given in the visualization of locations, which is believed to be superior to that gained where pupils make their own maps. The only training in map drawing that is given in the course is in reference to projections so that the pupils may understand maps of large area. Map

Distribution of rainfall by seasons. Distribution of rainy and desert areas.
Relation of rainfall areas to general and seasonal winds.
Distribution of highlands and lowlands in reference to winds.
Influence of highlands and of lowlands upon rainfall and temperature.

Surface.
Plateau character of region and general absence of lowlands.
Introduce idea of aging of land forms and advantages and disadvantages of a little-dissected plateau.
General distribution of highlands, comparison of Northern and Southern Africa as to average height.
Effects of highlands upon temperature, rainfall, etc.
The Atlas mountains, their distribution, general character, and importance.
The principal features of mountains. Character and relation to life of young and old mountains.
The highlands of Abyssinia.
The Great Rift Valley. Its formation, peculiar features, and importance.
The volcanoes of East Africa.

Coast Line.
Advantages to a continent of ready access to ocean, from standpoints of climate, commerce, defence.
Ideal coast line. — Review of features and importance of coast line of Europe.
Coast line of Africa.
Its regularity, its relation to interior plateau and coastal lowlands, where they occur.
Gulfs, capes, and islands of Africa located and described. Relation of Madagascar to mainland.
Importance of northern coast of Africa in ancient times, of western coast ports in slave and ivory trade, and southern coast to English and Dutch.

Drainage.
The position of the larger rivers and lakes of Africa, both in reference to climatic divisions and to highlands.
Important features of rivers from human standpoint; length, large volume, gentle slope, absence of falls, favorable location climatically.
Failure of African rivers in certain of these particulars. Effect of presence of waterfalls.
Absence of great highway into interior of continent.
The Congo Basin.
Position and chief divisions.

**drawing and modelling are reduced to a minimum, but great attention is given to the filling in of details on blank outline maps.**

Size and volume. Relative size as compared with Amazon and Mississippi.
Relation to rainfall.
Character of its different divisions. — Tanganyika, Stanley's Pool.
History of discovery and exploration; present mastery of Congo.
Chief products of Congo Basin. Character of native peoples.
The Nile Basin.
Position, volume, and divisions of Nile.
Relation to rainfall and topography. Necessity for irrigation. Its effect on life habits.
Absence of tributaries in lower portions of Nile; reasons therefor.
The alluvial plain.
Its origin, character, and importance.
Idea of aging of stream developed; aggrading and degrading work of rivers worked out; value of old rivers.
The Delta.
Its growth and reasons therefor.
Origin and character of waste.
The principal distributaries and their character.
Significance of location of Cairo and Alexandria.
Their importance historically.
Vegetation Regions of Africa.
Distribution of vegetation regions according to latitude.
The Mediterranean and the Cape regions.
The Sahara and the Kalahari Deserts.
The Savannas and Wet Jungles.
The Mediterranean Region.
Review of topographic features and climatic location.
General character of vegetation.
The leading products and occupations of peoples as related to topography and climate.
The distribution of peoples and the division of the area politically.
Leading cities located and studied, including Tangiers, Fez, Algiers, Tunis, Tripoli.
The Cape Region, considered as above, including account of present South African conditions. Compare with Mediterranean Region in as many ways as possible.
Means of communication and commerce considered, including telegraph lines, Cape-Cairo Railroad, etc.
Leading cities studied, Cape Town, Cape Elizabeth, Kimberley, Johannesburg, Pretoria.
The Sahara.
Location and extent. Relative size compared, for instance, to Europe.

Location in reference to wind systems and rain belt.
Origin of deserts considered. Sahara a *dry* desert.
Desert conditions. Absence of moisture, of rainfall, rapid and great changes of temperature, wind erosion, dry stream beds (wadis), general absence of vegetation, oases, etc.
Means of migration and leading caravan routes and races occupying the Sahara.
Surface features of Sahara; drainage lines, and relation to Nile.
Products of Sahara, in kind and in value.
Sahara as a great barrier.
The Kalahari Desert.
Compared in position, in character, in products, etc., with the Sahara.
The Savannas and Jungles of Equatorial Africa.
Location, climate, and rainfall.
Character of surface, leading mountain ranges.
Distribution of forested and grassy areas in reference to climate and topography.
The steppes bordering the savannas.
Great drainage lines compared with Congo.
Products, native peoples, and political divisions of tropical Africa. Special treatment of the Sudan.
Summary.
Political divisions of Africa. Colonies in Africa.
Distribution of native races.
Importance of Africa politically and commercially.

*Australia*

Location in latitude and longitude.
Location in heat belts and wind systems.
Area as compared with Europe.
Why a continent rather than an island.
Relation to Asia and Australasia.
Coast line.
Continental shelf.
Larger indentations of Gulf of Carpentaria and Great Australian Bight.
Comparison of eastern with western and southern coasts.
Extent and importance of Great Barrier Reef.
Physical Features.
Extent, height, and character of eastern highlands.
Drainage lines determined by highlands.
Lowlands of southeast.
Western plateaus and deserts.

Climate.
- Expected climate according to position and relief.
- Climatic features as determined from isotherm and rainfall maps.
- Effects of eastern highlands on temperature and humidity.
- Distribution of rainfall; extent of western desert.

Products.
- The animals of Australia compared with those of other continents.
- The plants and their distribution according to climate and topography; the wheat and sheep industries.
- Other economic products, such as gold, copper, iron.

People and Industries.
- Character, distribution, and occupations of native races.
- Leading occupations of people, exports, and chief trade centres.
- Location and importance of larger commercial cities, i.e., Sydney, Melbourne, Brisbane, Adelaide, Perth.
- Distribution of peoples, railways, telegraphs, etc., as related to climatic and topographic features.

Political Divisions.
- Present political divisions and development of Australian Commonwealth.
- Comparison with South Africa in physical and political conditions.

Related Islands.
- Treat Tasmania and New Zealand briefly as to:
  - Location, relation to Australia, climate, products, and importance.

## *North America*

Location by latitude and longitude and relation to Europe. Size and general form.
- Larger features.
  - Eastern and western highlands.
  - Central and coastal plains.
  - Height of land.
- Consequent lines of drainage.
  - Arctic drainage.
  - Pacific drainage.
  - Atlantic drainage.
    - Direct.
    - St. Lawrence.
    - Gulf.
  - Interior drainage.
- Comparison of coast line on east and west — as to general form, number of harbors, temperature of harbors in winter, nearness to foreign markets.

Climate.
- Distribution of North America in reference to winds.
- Summer and winter distribution and range of temperature.
- Influence of ocean in equalizing conditions.
- Relation to ocean currents.
  - Develop scheme of ocean currents, as related to temperature and winds.
  - The North Atlantic drift compared to other drifts.
  - The Gulf Stream and Labrador current.
- Range of temperature along Atlantic coast as determined by position in lee of continent and in relation to contrasted ocean currents.
- Distribution of rainfall as influenced by:
  - Prevailing winds.
  - Proximity of ocean.
  - Presence of great land barriers.
- Products.
  - Relation of vegetation regions to climate and topography.
  - Relation of distribution of animal life to food supplies.
- Population.
  - Distribution of population as compared to climate, topography, drainage lines and coast line.

*Detailed Study of the United States*

New England.
- Distribution of upland and lowland.
  - Character and extent of, and general effects of, on distribution of peoples and occupations.
  - Principal lines of drainage and importance.
  - Glaciation and its effects.
    - On uplands as to soil and habitability.
    - On lowlands as to soil, topography, and general habitability.
      - Principal centres of colonization and reasons therefor.
      - The resources and history of the Connecticut Valley.
    - On drainage.
      - Gorges.
      - Waterfalls and power; the valley of the Merrimac being studied in detail.
      - Lakes, as reservoirs, as moderators of climate, as health and pleasure resorts.
- Leading industries and products.
  - Lumbering and fishing.
  - Manufacturing.
  - Market gardening.
    - General character of each industry, with its location and

the leading cities engaged in the industry. Special study of growth and importance of Boston.

Commerce routes.

Land and water routes used commercially, and as related to topography.

Effect of topography on Western trade.

New York State.

Distribution of Highlands and Alleghany Plateau.

Character of uplands as in New England.

Brief summary of geological history of New York State.

The valley of the Hudson and of the Mohawk.

The climate of uplands and lowlands, of lake plains and coastal regions.

Principal lines of drainage and relation to topography.

The resources of New York State to be worked out from knowledge of topography and climate, and then verified in details.

Products of soil of Mohawk lowland and Long Island Plain, with special emphasis on hay, corn, hops, and truck farming.

Vineyards of lake region of Cattaraugus and Chautauqua Counties.

Dairying of St. Lawrence, Jefferson, Delaware, Oneida, and Orange Counties.

Forests of Adirondack Highlands and Alleghany Plateau.

Value of forests for lumber, wood pulp, as health and pleasure resorts. Influence of lakes in highlands.

Marble, building stone, cement, oil, etc., of Alleghany Plateau.

Salt of Onandaga County.

Mineral springs of Livingston and Saratoga Counties.

Fishing of lakes, Hudson river, and ocean, especially white fish, shad, oysters, clams, and menhaden.

Manufacturing of Buffalo, Syracuse, Troy, Binghamton, Little Falls, Glens Falls, etc.

Commerce of New York, Buffalo, Brooklyn, etc.

Leading commerce and transportation routes, considered historically and in present conditions.

Influence of climate, topography, and drainage on development of New York State.

Especial study of salient features of New York City and vicinity, including eastern New Jersey and western Connecticut. This work is largely based on a series of field excursions to various localities: to Bronx Park, to study topography and drainage; to Palisades of the Hudson, for a similar purpose; to an importer's warehouse, or to an ocean steamer for a study of commerce; and to the coal wharves and beef packing establishments at Manhattanville, to study these industries as determined in location by the physical features of their vicinity.

Atlantic Coastal Plain.
- Boundaries of coastal plain on land and on water side. Fall line.
- Extent of plain, by states and parts of states.
- Climate of plain, summer and winter. Variation in climate.
- General character of plain, as to soil, slope, lines of drainage, amount of aging, etc.
- Recent history of plain and how determined.
- Shore line and drowned valleys. Importance of these in history.
- Present use of shore line.
- Distribution of economic products of plain, with especial attention to agricultural products, such as tobacco, cotton, rice, oranges, etc.; to mineral products, such as phosphate, sands, clay, etc.; to forest products, such as lumber, resin, etc.
- Influence of these conditions on colonization and manner of life in colonial times.
- Distribution of leading cities.
  - Coastal cities: Atlantic City, N. J., Norfolk, Va., Wilmington, N. C., Charleston, S. C., Savannah, Ga., Tampa, Fla.
  - Cities near "fall line": Trenton, N. J., Philadelphia, Pa., Baltimore, Md., Washington, D. C., Richmond, Va., Raleigh, N. C., Columbia, S. C. Influence of estuarine conditions in reference to certain of these.
- Particular study of coastal area of New Jersey.
  - Relation of coastal area to old land area.
  - Distribution of topography and soils, as seen in lowland, ridges, plain, and beach.
  - Distribution of occupations and people in these areas.
  - Influence of topography on lines of communication, especially in reference to New York, Philadelphia, and the South.

The Appalachian Region.
- Distribution of Appalachian region by states.
- Boundaries of region on east and west, on north and south.
- The area as a highland, influencing:
  - Climate and vegetation.
  - Drainage lines.
  - Distribution of peoples.
  - Migration of peoples.
- The division of the area into —
  - Old land belt.
  - Great Valley.
  - Alleghany Plateau.
- Distribution and topographic features of these divisions, including brief summary of geological history of the region.

Special study of geography of Pennsylvania.
Topographic character of each great division in Pennsylvania.
Drainage of Pennsylvania as seen in Susquehanna and Alleghany rivers.
The importance of water gaps of Delaware and Susquehanna rivers.
On development of state historically.
On development of interior of continent.
On commerce by rail and water.
Distribution of soils and minerals according to topographic divisions.
Reasons for development of coal and iron mining and steel manufacturing.
Reasons for importance of leading cities: Pittsburg, Scranton, Reading, Bethlehem, Philadelphia.
Location and importance of water gaps in southern Appalachians.
Influence of drainage lines on development of region.
Principal products of region, and distribution thereof, especially coal, iron, oil, and lumber.
Location and importance of leading cities, such as Wheeling and Parkersburg, W. Va., Chattanooga and Knoxville, Tenn., Birmingham, Ala., Asheville, N. C., Atlanta, Ga.
Detailed study of vicinity of Chattanooga, Tenn., with especial emphasis of relation of topography to the incidents of the Civil War.
Gulf Plain.
Distribution of Gulf Plain by states.
Relation to Mississippi river and to Atlantic Plain.
Climate of region, with especial note of rainfall and summer temperature.
Shore line features.
Drainage of plain.
Soil and topography, and influence on agriculture. Special study of soil features of Mississippi river, an old river plain.
Principal agricultural products and their distribution.
Relative importance and conditions of principal cities: Pensacola, Fla., Mobile, Ala., Vicksburg, Miss., New Orleans, La., Galveston and Houston, Tex.
Prairies and Great Plains.
Distribution of region as a whole, including extension into Canada.
Climate of region, with particular emphasis of summer and winter temperatures and winds; distribution and amount of rainfall.
Division of regions climatically into Prairies and Great Plains.

Prairies.
- The Prairie States, their position and importance.
- Topographic features of Prairie States.
- The soil and drainage of the prairies.
- Other features of the Prairie States, especially Michigan, Minnesota, Wisconsin, and Missouri.
- The distribution and value of leading agricultural products.
- Lines of transportation and commerce.
  - The Great Lakes and navigable rivers.
  - The leading railroad lines and relation to topography.
- The leading cities of area, related to their environment, especially Cleveland and Cincinnati, O., Louisville, Ky., Detroit, Mich., Chicago, Ill., Milwaukee, Wis., St. Paul and Minneapolis, Minn., Omaha, Neb., Kansas City and St. Louis, Mo.
  - Detailed study of geographic conditions of Chicago, and reasons therefor.

The Plains.
- Distribution of plains, and relation to prairies and Rocky Mountains.
- Detailed consideration of climate of plains.
- Topographic features of plains, and character of drainage.
- Industries of plains as related to topography and climate. Methods and results of irrigation.
- Cities of plains, especially Great Falls, Mont., Cheyenne, Wyo., Denver and Pueblo, Colo.

Rocky Mountains.
- Alignment and extent of Rocky Mountains.
- Relation to Cordilleras, and extension into Canada.
- Distribution of heights in Rocky Mountains; relation of heights to continental divide.
- Influence of height on climate and vegetation and transportation. The principal railway lines and passes.
- Effect of mountains on climate of plains.
- Scenic features of the region, especially the Yellowstone Park, the Colorado "Parks," and leading mountain peaks of Colorado.
- The principal mining centres of the mountains, their location and importance.
- The leading cities and their characteristics: Butte and Helena, Mont., Laramie, Wyo., Leadville and Cripple Creek, Colo.

The Great Basin.
- The extent and climatic features of the Great Basin; relation to Columbia and Colorado Plateaus.
- Reasons for climate of area.
- Recent climatic history of area, in brief, with especial reference to Great Salt Lake.
- Industries of region. Importance of irrigation.

Salt Lake City and its history.
The Colorado Plateaus.
The extent and climate of the Colorado Plateaus. Influence of altitude on climate.
The topography and its origin.
The Colorado river and canyon; source of water; arrangement of tributaries. The size and grandeur of the canyon.
The industries of the region.
The inhabitants, both ancient and modern, with brief note of some of the Indian customs, like those of the Mokis.
The leading cities: Prescott, Phœnix, Tucson.
The Columbia Plateaus.
Character and extent of area.
Geological history of plateaus.
Climate and occupations of people.
The Pacific Ranges.
The extent and subdivisions of the area.
Sierra Nevada.
Cascade Mountains.
Coast Ranges.
California Valley.
Relation of the area to the Cordilleran Highland.
Influence of alignment and height of area upon climate. Effect upon interior regions.
Climatic conditions, summer and winter.
Relation to wind systems.
Distribution of rainfall by seasons, with special emphasis on Washington and Southern California.
Drainage of the area.
Importance of the Columbia, Sacramento, and San Joaquin Rivers.
The character of the shore line. Contrast with Atlantic shore line in form and in climate. Importance of Puget Sound and San Francisco Bay.
Brief history of the development of the region, including review of overland routes, first discovered and used. Present commerce and trade routes, both internal and external.
Products and occupations.
The distribution, character, and importance of forests as related to climate. The Big Trees of California.
The agricultural areas and their distribution.
The mining regions and their history in brief.
The fishing of the Columbia river, and its importance.
Special features of region.
The great mountains and dormant volcanoes.
Crater Lake.
The islands, and southern coast.
Cities and towns.

Seattle, Wash., Portland, Ore., San Francisco and Los Angeles, Cal.

The countries north of the United States.
- Topographic and climatic relation of Canada to the United States.
- Climatic divisions of Canada.
- The Provinces of Canada and their relative importance as determined by climatic position.
- The leading products of the several regions. The occupations and habits of the inhabitants.
- The great trade routes and leading cities.
- The position, climate, and topography of Alaska.
- Present interest in Alaska and reason therefor.
- The great rivers of Alaska and their importance.
- Leading industries of Alaska and importance to the United States.
- The position, character, and importance of Greenland.

The countries south of the United States.
- Topographic and climatic features of Mexico and Central America.
- Political divisions of Central America.
- Character of people.
- Products and occupations as determined by topography and climate.
- Commerce, both internal and external, and routes thereof.

The leading islands of the West Indies, and their importance to the United States.

The climate and products of Haiti, Cuba, and Porto Rico.

### *South America*

Position.
- In reference to land mass.
- In reference to latitude and longitude — to oceans.

Climate.
- Trade wind and doldrum belts.
  - General features.
    - Direction of trades — their character — characteristics of doldrum belt — its extent — migration of belts — region of shifting doldrums and trades.
  - Rainfall. (Study physical maps and maps showing distribution of rainfall.)
    - Rainfall of trades and doldrums compared.
    - Comparison of eastern and western coasts and interior, of highlands and lowlands, of windward and leeward mountain slopes in trade wind belt.
    - Results of migration of doldrums and trades.

Rainfall of Orinoco — July and August, December and January.
Rainfall at head waters of Parana — Comparison with Orinoco.
Regions having two rainy and two dry seasons.
Temperature. (Isothermal map used.)
Temperature of trade wind and doldrum belts.
Heat equator for January and July located.
Temperature of eastern coast, of interior, of western coast compared.
Temperature of lowlands and highlands of same latitude. Winter and summer temperature of Lima, of Rio Janeiro, etc.
Sub-Tropical belt.
General features.
Region of shifting westerlies and trades. Direction of westerlies.
Reason for migration.
Rainfall.
Effect of these winds upon rainfall of countries, e.g., Chile — Season of greatest rainfall, of least — Comparison with countries in belts of shifting doldrums and trades.
Temperature.
Temperature of summer, of winter, of highlands, of lowlands.
Westerlies.
General features.
Region in which westerlies blow steadily — their character.
Rainfall.
Eastern and western coasts compared — Comparison with trade wind belt. Difference accounted for.
Temperature.
Temperature of summer and winter — temperature of coasts, of interior.
Surface.
Eastern highlands — Guiana, Brazil.
Central lowlands — Orinoco Plain, Amazon Plain, Paraguay — Parana Plain, Patagonia — Pampas Area.
Andes.
Guiana highland.
Surface features.
Extent, elevation, and character of highland.
Principal river — character of stream, of valley.
Topography compared with that of region directly north.
Climate.
Temperature.
Rainfall of northern and southern slopes.
Products of highlands — occupations.

Location of chief towns of Guiana accounted for. Explain absence of large towns in highlands (Guiana) of Venezuela — on adjacent coastal plain.

Brazilian highlands.

Surface features.

Extent of highlands, elevation — comparison of eastern and western slopes.

Influence of highlands upon rivers.

General direction of rivers — effect of barrier, e.g., São Francisco — character of rivers.

Climate.

Winds — temperature.

Rainfall of hot months — Precipitation during dry season.

Products and occupations.

Forests — Location accounted for.

Chief agricultural products — Region adapted to agriculture.

Grazing products — Region devoted to grazing.

Chief ports — Rio de Janeiro, Santos, Bahia, etc. Account for location.

Countries receiving products — Routes of transportation.

Andes.

Their extent — direction — region of greatest altitude, of greatest breadth.

Compare with Rocky Mountains, with Brazilian Highlands.

Southern Andes — including coast strip.

Character of mountains.

Character of coast — Irregularity accounted for — Comparison with similar coasts of North America.

Highest peaks located — their elevation — compare with country lying directly west. (Plain of middle Chile.)

Rivers flowing westward and eastward compared.

Climate.

Winds, temperature, rainfall.

Products.

Coal, gold, etc.

Forests (animal life of forests).

Grains and vineyards (Plain of Chile).

(Variations in topography and climate leading to differences in products and occupations shown.)

Chief port — account for location — routes of transportation.

Middle Andes.

Character of mountains.

Plateau of Bolivia — Its altitude, boundaries, northern and southern parts compared. Plateau compared with Great Basin (North America), with Andes of Peru.

Drainage.

Its character.
Former outlet of Lake Titicaca — size of lake — elevation.
Climate.
Compare climatic condition of desert of Atacama with eastern slope of Andes in same latitude — with country lying directly south.
Products and industries.
Mines — silver, copper, nitrate, etc.
Forests — rubber, cinchona.
Related industries, etc.
Chief commercial towns — routes of transportation.
Northern Andes.
Character of mountains.
Volcanoes — principal cones — nature of volcanoes — height.
Drainage — direction of streams — how determined.
Climate — influence upon location of towns.
Products — occupations.
Forest products —animal life of forests.
Products of mines.
Agricultural products.
Related occupations.
Commercial towns and commercial routes.
Amazon Plain.
Extent of basin — its character — direction of slopes.
Amazon river.
Size of river — navigability — main tributaries. Relative amount of detritus carried to sea. Alluvial deposits compared with deposits of Mississippi. Similarities and differences noted.
Climate.
Temperature — reason for amount of rainfall.
Relation of climate to life.
Favorable or unfavorable for man. (Map showing distribution of population.)
Animal life — varied forms — adaptation to environment.
Plant life — tropical forests — selvas described.
Products of forests.
Occupations — Methods by which natives obtain products.
Chief port for region. Destination of products. Commercial routes.
(Remaining lowland regions studied in a similar manner.)

Summarize work on South America by a brief survey of the leading countries, noting in each instance their extent, and identifying surface features, climate, and products with countries.

## Stage V

Eighth Grade, three periods of thirty minutes each for first half year.

The last stage in the elementary course is devoted to a comparative study of the world from the physical standpoint, the continent of Eurasia being the basis of work. The object of the work is to give the pupils a comparative view of the salient features of the several continents. The continent of Eurasia is chosen as the medium through which the comparisons are made, because it is the most important of the continents next to the Americas, and hence offers an excellent opportunity for comparison with the other continents, particularly from the standpoint of physical control on life. Eurasia is not as simple a continent as Africa or Australia, for instance, and thus should be studied last, when the pupils are best able to understand exceptions to simple laws, and to appreciate deeper generalizations. Though the first object is a knowledge of Europe, the final aim is a related and well-ordered knowledge of the world as a whole, and especially of the broader geographical principles of human geography.

The method of comparing each large fact with similar facts in other continents allows the gradual building of generalizations that can be seen not to be absolute, and yet which give the very best point of view for pupils who are to pass into secondary work and the study of the elements of other sciences, which are best based on such a general point of view in reference to science as can be given by physical geography in the elementary school. In other words, the aim is to make the work of Stage IV reach a climax in Stage V that shall have a great culture as well as an informational value to the pupils.

### *Eurasia*

Position, form, and size.
- Relation to land mass.
- Antipodal arrangement of land and water.
- Relation to oceans and ocean currents compared with North America and South America.
- Character of shore line noted.
- Compare in peninsularity with other continents; what may you infer therefrom?

Latitude and longitude. What does this suggest as to climate of interior and as to variation of climate with latitude?
Size compared with North America — with other continents. Relative proportions of Europe and Asia.

Climate.
Temperature.
Heat belts. (Isothermal maps used.)
Compare temperature of coasts and interior for January and July.
Compare east and west coasts, 40° N. Lat., with same points in western hemisphere.
Region of greatest extremes. Compare with North America. Cause suggested.
Coldest area. Compare with coldest area of North America in position and extent.
Winds.
Direction of prevailing winds in northern Eurasia — in southern Eurasia.
Relation of winds to highlands, compare with North America and Australia.
Rainfall.
Relation of rainfall to winds.
Region of greatest rainfall — of least rainfall. Comparison of these regions with similar regions in North America, in regard to extent, in regard to amount of precipitation, and in regard to line of greatest rainfall. Compare in a similar way to Africa.
Influence of topography upon rainfall — e.g., Himalayas, Central Asia, etc. Compare with Africa and Australia.

Topography.
Trend of great highland — Greatest altitude and breadth.
Position of highland in continent mass. Importance of highland as compared with the Americas.
Principal ranges — Compare with Andes and Cordilleras.
Northern lowland — elevation, character, and extent of surface.
Compare with North America in topography, position, and climate.

Drainage.
Principal rivers — compare in length, position, and importance with rivers of North America; with rivers of South America.
Inland seas — Characteristics — Influence commercially. Compare with Great Lakes of North America.

Vegetation and animal life.
Vegetation of northern Eurasia compared in character and in distribution with that of North America — animal life compared.

Great forest belt. Products of forest — animal life.
Steppes. Distribution and products of region. Compare with South America.
Deserts. Characteristic vegetation. Compare in position and origin with deserts of North America, of South America, of Africa, and of Australia.
Forests of southeastern Asia compared with northern forests. Animal life of region. Compare forests of Asia with those of Africa.
Animal and plant life of highlands compared with Africa and South America.
Minerals.
Regions in which minerals are most abundant. Chief mineral products compared in distribution with other minerals studied.
Great industries of Eurasia, and general distribution thereof.
Distribution of population accounted for from knowledge of climate — surface features.
Main commercial routes, both for internal and external commerce.

*Europe*

Position and relation to Asia briefly reviewed.
Relation to surrounding waters, as shown by continental shelf — significance of this in reference to France and British Isles.
Climate.
Temperature.
Heat belts — seasons of belts. (Isothermal maps used.)
Temperature of coasts and interior for July and January compared.
Temperature of western Europe compared with eastern North America.
Trend of isotherm of 30° F. for January explained.
Influence of Mediterranean on southern Europe.
Temperature range of eastern and western Europe compared.
Winds.
Prevailing winds of northern Europe — of southern Europe — Compare with North America.
Rainfall.
Regions of heaviest rainfall in northern Europe — in southern Europe.
Regions of lightest rainfall.
Season of heaviest rainfall of southern Europe accounted for. Compare with southern California, with South Australia, with middle western coast of South America.
Influence of topography upon rainfall.

Topography.
  Great physiographic divisions — northern and southern highlands compared, noting character, altitude, trend, etc.
  Chief highland regions — Alps and Himalayas compared — Scandinavian and Laurentian highlands compared.
  Extent of lowland.
Drainage.
  Control of rivers by topography — Exceptions noted — Comparison with condition found in North America.
  Drainage systems — Greatest rivers — Compare with great rivers of other continents.

On account of the complexity of structure a detailed treatment of Europe by countries seems advisable. The mode of treatment outlined below is typical for the various countries of Europe, each region being treated so far as possible by physical divisions.

*Scotland* (*an old mountain region*).

Position.
  Relation to Great Britain — to continent of Europe.
  Surrounding waters.
    Character of shore line — old shore line accounted for — shore line compared with Norway, Alaska, and New Zealand.
  Latitude extent.
    Region of corresponding latitude in North America.
Climate.
  Temperature.
    Compare with corresponding latitude in North America. Reason for difference found.
    Eastern and western coasts compared. Compare with British Columbia.
  Winds and rainfall.
  Direction of prevailing wind. Slopes receiving heaviest rainfall.
    Amount of seasonal distribution of rainfall.
Physical features.
  Highlands.
    Character, formation.
    Drainage — effect of glaciation. Compare with Maine, Massachusetts, etc.
      Principal rivers — their character, direction, etc. Lake basins and their influence.
    Effect of climate and topography upon character of people, upon occupations, upon distribution of population. Compare with New England.

Central lowland.
Topography of lowland — formation — evidences of vulcanism, of glaciation, of drowning. Compare with Connecticut valley.
Most important rivers— their courses.
Resources.
Fertility of soil.
Mineral wealth — iron and coal, etc.
Industries and exports.
Chief towns — location accounted for.
Population compared with highland region.
Influence of lowland in history.
Southern uplands.
Principal rivers.
Industries — control of topography shown. Exports.
Chief towns — their location.

*Spanish Peninsula (a plateau)*

Position.
With relation to continent, to surrounding bodies of water.
Latitude.
Region of corresponding latitude in North America.
Climate.
Compare temperature of coast and interior. Direction of prevailing winds, — winter and summer. Rainfall of coast, of interior. Compare with corresponding region in North America.
Topography.
Highlands.
Chief mountain ranges — their character, elevation, trend. Barrier between France and Spain (course of railroad noted).
Iberian Plateau. Character, general elevation. Effect on distribution of population. Madrid.
Lowlands.
Position, extent.
Compare highlands and lowlands with those of Africa. Contrast arrangement with highlands and lowlands of Australia.
Drainage.
Principal rivers — their directions — main divide.
Size of rivers on plateau accounted for — characteristics of rivers — reason for falls and rapids — basins of Douro and Tagus compared with Guadalquiver. Basins of North America similar to Douro and Tagus recalled.
Work of streams on eastern and western coasts accounted for.
Products and exports.

Influence of climate and topography upon vegetation — vegetation of plateau and coast compared and explained.
Animal products — regions devoted to grazing, to mining — products of mines. Chief exports.
Distribution of population.
Compare plateau and coast regions — Reasons for difference found.
Cities — commercial routes.
Centres of manufacturing, of commerce, etc.
Location of principal towns accounted for.
Routes of exportation.

France, Italy, Switzerland, and Greece treated in a similar way, and the countries of the northern plain treated as a unit as to general features and then divided for special consideration.

Summarize by generalizations in reference to the relation of life and occupation to position, climate, coasts, old and young rivers, dissected and non-dissected mountains and plateaus, coastal plains, etc., as shown by study of all the continents.

### Texts Used in Several Stages

Stages I and II.
*Around the World Readers.* First and Second Book.
Stage III.
Tarr & McMurry, *North America.*
Longmans, *New School Atlas.*
Redway & Hinman, *Natural Elementary Geography.*
Stage IV.
Longmans, *New School Atlas.*
Redway & Hinman, *Natural Advanced Geography.*
Stage V.
Lyde, *Europe.* A. and C. Black.
Longmans, *New School Atlas.*

### Selected List of Reference Reading Available for Pupils

Stages I and II.
Payne, *Geographical Nature Study.* American Book Co.
*World and Its People.* Vols. I and II. Silver, Burdett & Co.
*Around the World Readers.* Books I and II. The Morse Company.
Andrews, *Seven Little Sisters.* Ginn & Co.
Andrews, *Ten Boys.* Ginn & Co.
Andrews, *Each and All.* Lee & Shepard.

King, *Picturesque Geographical Readers.* First Book. Lee & Shepard.
Olive Thorne Miller, *Little People of Asia.* E. P. Dutton & Co.
Frederick Schwatka, *Children of the Cold.* Cassell Pub. Co.

Stage III.

Carpenter, *North America.* American Book Co.
Carpenter, *Asia.* American Book Co.
Tarr & McMurry, *North America.* Macmillan.
Frye, *Primary Geography.* Ginn & Co.
Redway & Hinman, *Natural Elementary Geography.* American Book Co.
*World and Its People.* Vol. III. Silver, Burdett & Co.
Frye, *Brooks and Brook Basins.* Ginn & Co.
King, *Picturesque Geographical Readers.* Second Book. Lee & Shepard.
Bayard Taylor, *Boys of Other Countries.* G. P. Putnam's Sons.
Mary M. Dodge, *Hans Brinker.* Charles Scribner's Sons.
Mary M. Dodge, *The Land of Pluck.* The Century Company.

Stages IV and V.

Carpenter, *North America.* American Book Co.
Carpenter, *South America.* American Book Co.
Frye, *Complete Geography.* Ginn & Co.
Redway & Hinman, *Natural Advanced Geography.* American Book Co.
Tarr & McMurry, *North America.* Macmillan.
Dodge, *Reader in Physical Geography for Beginners.* Longmans.
*World and Its People.* Vol. IV. Silver, Burdett & Co.
Shaler, *Story of Our Continent.* Ginn & Co.
Herbertson, *Man and His Work.* A. and C. Black.
Lyde, *North America.* A. and C. Black.
Lyde, *Africa.* A. and C. Black.
Lyde, *Europe.* A. and C. Black.
Lyde, *Asia.* A. and C. Black.
Herbertson, *Illustrated School Geography.* Arnold.
King, *Picturesque Geographical Readers.* Third, Fourth and Fifth Books. Lee & Shepard.

High School.

Davis, *Physical Geography.* Ginn & Co.
Tarr, *Elementary Physical Geography.* The Macmillan Company.
Tarr, *First Book of Physical Geography.* The Macmillan Company.
Hinman, *Eclectic Physical Geography.* American Book Company.
Russell, *Rivers of North America.* Putnam.

SELECTED LIST FOR TEACHERS

General.

*Longmans' Gazetteer.* Longmans. The authoritative pronouncing and spelling gazetteer of the world.

*Stieler's Hand Atlas.* Perthes. The leading reference atlas.

Mill, *Hints to Teachers and Pupils on the Choice of Geographical Books for Reference and Reading.* Longmans. A valuable list of reference books selected by a leading authority.

Mill, *International Geography.* Appleton. The best single volume reference book on general and regional geography.

*Stanford's Compendia.* Reissue. Stanford. Volumes on Asia, Africa, Australasia, North America and Europe, written by experts. The leading recent reference books on the individual continents.

*Bulletin of the American Bureau of Geography,* Winona, Minn. (Periodical.)

*Journal of School Geography,* Lancaster, Pa. (Periodical.)

Methods.

Geikie, *The Teaching of Geography.* Macmillan. A very suggestive book on the essentials of good geography teaching.

McMurry, *Special Method in Geography.* Public School Publishing Co. Devoted to the Mississippi Valley, and emphasizes teaching by selected topics.

Physical Geography.

Mill, *Realm of Nature.* Scribner's. A very valuable and simple book on physical and mathematical geography and on biogeography.

Davis, *Physical Geography.* Ginn & Co. An authoritative secondary school text, particularly helpful in reference to the land features.

Davis, *Elementary Meteorology.* Ginn & Co. The leading English book on weather and climate.

Ward, *Practical Exercises in Elementary Meteorology.* Ginn & Co. Very helpful to teachers who have to deal with weather phenomena.

Davis, King & Collie, *The Use of Governmental Maps in Schools.* Henry Holt & Co.

Biogeography.

Keane, *Ethnology.* Cambridge University Press. One of the leading books on the races of men.

Ratzel, *History of Mankind.* (3 Vols.) Macmillan. A very comprehensive book on the races of mankind, the first volume being particularly valuable for its consideration of the problems of race distribution.

Wallace, *Island Life.* Macmillan. Classic book on animal distribution from geographic standpoint.

Guyot, *Earth and Man.* Scribner's. One of the older books, and hence not written from a modern standpoint; but still invaluable for presenting the relation of earth features to life.

(See also chapters in International Geography, noted above.)

### The Secondary Course in Physical Geography

Time, two periods of thirty-five minutes each; one period of eighty minutes.

The field to be covered in a course of physical geography in a secondary school is well blocked out by the better text books on the one hand, and the entrance examinations for certain universities on the other. The Earth as a Whole, the Atmosphere, the Land, and the Water, are the four divisions accepted for the work, as was clearly outlined by the Sub-Committee of the Committee on College Entrance Requirements of the National Educational Association.[1] Opinions differ, however, as to the order of treatment, as to the plan of treatment, i.e., amount of laboratory and field work, etc., as to the amount of time to be given to each topic, and concerning the year of the secondary school in which the work should be given. In the Horace Mann School the course is outlined to satisfy the requirements for entrance to Columbia College, and hence must be given in the later years of the course.[2] The course is given in two single thirty-five minute periods, and one double period of eighty minutes weekly. More than half of the time is devoted to laboratory and field work, and there is a certain amount of library work besides the study of the text. Davis's *Physical Geography* is used as a source of reference, but the text is used after the class presentation of the subject rather than before it.

[1] *Journal of School Geography,* September, 1898, pp. 248-262. *Proceedings National Educational Association,* 1898, pp. 973-984; 1899, pp. 780-794.

[2] Physical geography is made such a strong and necessary part of the elementary school geography work that an introductory course in the subject in the first or second year of the secondary school is unnecessary and would not be much in advance of the work of the grades.

### *The Aim of the Work*

The best thought in reference to secondary work in physical geography, as expressed by the leading teachers and in the foremost texts in current use, is unanimous in agreeing that there should be no endeavor to present a complete course in any one of the several elementary subjects that contribute naturally to work in physical geography. Meteorology, Oceanography, Geomorphology, and Anthropogeography, as such, should be left for the colleges, or perhaps in some cases may be given as electives in the advanced years of the High School. In physical geography the aim should be to give the pupils training in scientific thinking and a knowledge of the relation and relative importance of the more important factors involved in considering causally the relation of the physical environment to man and life. The several topics would lose in value and in interest if the life side were omitted, and thus life effects should have an important amount of attention.

In the course in the Horace Mann School the life effects are brought in constantly as each topic is treated so that the pupils may see each topic in its practical significance. The effectiveness of this method of procedure is far superior to that when the topics are treated in a straight, scientific sequence, leaving the application to life to a few summary exercises at the end of the course. It should not be supposed, however, that such a treatment precludes the possibility of summarizing chapters in human geography at the close of the course. Indeed, such a summary is of great value in bringing together the many topics that may have been somewhat scattered in the progress of the work. If time allows, such exercises should be incorporated.

Finally it may be said that the course in the Horace Mann School is not a course in human geography from the physical side, but a logical, progressive, scientific course in physical geography, with a very strong life flavor thereto.

### *Plan of the Course*

The order of topics outlined above, i.e., Earth as a Whole, Atmosphere, Land, and Water, is preferred for several reasons. The first two topics are necessary preliminaries to a causal and

scientific study of the land forms, and hence should precede the Land and Water. There is no especial reason from the standpoint of cause why the water should precede the land, and hence it is put last: that the land may be treated early so as to make the work practical and interesting; that it may be treated fully and without omission of serious points; and because the oceans are less important than the land from the standpoint of human relations to the earth.

In each division of the course as much is taught as is necessary for the causal understanding of facts that follow in later sections, and the work is accurate and scientific. No attempt is made, however, to make an exhaustive study of the elements of physical geography, a field of study much better reserved for the early college years.

The course which is outlined below has been the outgrowth of several years' experience and study, during which time the course has been given by three others besides the Professor of Geography. The suggestions for library work and certain details in reference to laboratory exercises are the work of Miss Harriet A. Luddington, Instructor in Geography in the Horace Mann High School in 1899–1900.

## The Course in Outline

General Introduction. — Description of the science of geography, methods of work, etc.

The earth as a whole —

- Shape.
  - Evidence of globular form.
  - Consequences of living on an earth of this shape.
- Size.
  - Measurement of the earth.
  - Relation of human life to size of earth.
- Motions.
  - Rotation.
    - Character of the movement.
    - Consequences of rotation — defining direction, determining relative position, measurement of time, day and night, flattening at poles. Life effects due to rotation.
    - Determination of latitude and longitude (briefly).
    - Use of latitude and longitude in navigation and land surveying.
  - Revolution.
    - Rate, path, and direction of revolution.

Most important effects of revolution.
Magnetism.
Compass, poles, variation, and lines of no variation.
Laboratory work.
Plotting diagrams to show,
Path of earth about sun and position at different seasons.
Inclination of axis and distribution of light at different seasons.
Direction of magnetic meridian.
Direction of true meridian, — the magnetic variation for the locality being given.
Special topics (for individual work).
What is a solar day, sidereal day, civil day?
What is mean time, standard time?
Find the origin and location of standard time belts.
What is the International Date Line? Locate.
What is a natural magnet? What is the lodestone?
Trace the history of the mariner's compass.
Compare the line of no magnetic variation with the earth's meridians.
Library work.
Size of earth — Davis, *Physical Geography,* pp. 12, 13–15.
Rotation of the earth — Davis, *Physical Geography,* pp. 15–17.
Foucault's pendulum — Thornton, *Physiography,* p. 246: Jackson, *Astronomical Geography,* p. 70; Goode, *Journal of School Geography,* October, 1899, pp. 298–302.
Latitude and longitude — Davis, *Physical Geography,* pp. 388–393.
Revolution.
Who were Copernicus, Galileo, Kepler, and Newton?
What were their theories and discoveries?
How received?
(See encyclopedias).
References.
Davis, *Physical Geography,* pp. 10–17.
Tarr, *First Book of Physical Geography,* pp. 3–7, 13–15.
Hinman, *Eclectic Physical Geography,* pp. 28–32, 43–54.

*The Atmosphere*

Introductory.
Composition — Offices of the atmosphere.
Brief explanation of instruments used for observation of atmospheric changes.
Thermometers —
Difference between
Fahrenheit, Centigrade, Réaumur.
Maximum and minimum.

Barometers —
Mercurial, aneroid.
Method of taking observations.
Method of recording.
Thermographs, barographs.

(Start records to run over one month, and to include observations of temperature, pressure, direction of wind, condition of sky, twice daily. Keep on blank forms furnished,[1] and at the end of the month compare the records with those given on the weather maps.

Take all records at certain definite times during the day, preferably at 8:30–9, 1–2.

Compare the readings taken from the mercurial barometer with records made by the barograph for same time.)

Temperature.
Introduction.
Source of heat.
Nature of heat — review of physical terms and principles, i.e., reflection, transmission, absorption, radiation, etc.
The relation of earth to sun, and the earth's position in space.
Character of seasonal and diurnal temperature depending on relation of earth to sun.
Relation of life to seasonal and diurnal temperatures.
Expression of temperature conditions by isotherms.

Laboratory work.
Construct a diagram according to directions given on pp. 400–402, Davis, *Physical Geography,* and, placing a small globe as there directed, answer the following questions:
Which hemisphere has the greater amount of sunshine at each season?

[1] Three blank forms of uniform size, each capable of receiving records for thirty-one days, are furnished students. The first form is a general weather blank, ruled into 32 horizontal spaces, and a sufficient number of vertical spaces for records to include three entries daily of following topics: Thermometer, barometer, wind (direction and general strength), character of day; the bottom space gives a place for averaging the records for a month. Forms two and three are ruled into 31 vertical spaces, and to tenths of an inch horizontally, each complete inch being marked by a darker line. The thermometric blank allows for a range of fifty degrees, and the barometric blank has the upper full inch marked 31 and the lower 28. By placing dots in the proper positions between the upright lines, the basis can be laid for rough barographic and thermographic curves for a month. Records for days when there are no school sessions are taken from the self-recording instruments.

How does the direction of the sun's rays vary at different seasons — in each zone?

How does the length of day vary at different seasons, in each zone?

Find at what time of year weak sunshine and short days prevail in any region; at what time strong sunshine and long days prevail.

How are the limits of zones determined?

What zones never have a vertical sun? What zones are never outside the limit of sunlight? Are there any regions that never have oblique rays?

What divisions of the year result from the succession of high and low temperatures? Are these divisions applicable all over the world? Reason for opinion.

Plot isotherms on blank United States weather map to represent the distribution of temperature in United States on a single day.[1]

Place by each station mentioned the temperature recorded for that place.

Connect by a curving line all places having a certain temperature, e.g., 40°. This is the isotherm of 40°. It divides the United States into two sections — one warmer than 40°, one colder.

Draw other isotherms for every even ten degrees, estimating the position of a line where the records are not given in even tens.

Make a summary of the facts of temperature distribution as shown by the isotherms drawn.

Color the portion of the map where the temperature is below 30° a dark blue. Color with red the portion where the temperature is above 40°.

Compare your map with the United States weather map for the same day; make any necessary corrections.

Study the United States maps for a week following the date of the one thus noted. Note the changes in temperature distribution.

Isothermal charts (to be studied in laboratory. Charts used those of Longmans' *New School Atlas*).

Study January and July isothermal charts of the world.

Contrast northern and southern hemispheres as to evenness of isotherms.

Find the hottest spot and coldest spot on each map. Where is the "cold pole" on the January map? What is the average temperature?

In what regions are the isotherms crowded together? In what regions are they wide apart? Meaning of such ar-

[1] The blank weather maps used are secured from the United States Weather Bureau. See p. 51.

rangements. Relation of these areas to distribution of leading nations.

In what regions are the isotherms most regular, nearest to direction of parallels? In what regions are they most irregular, and in what direction? Meaning of each arrangement.

How do oceanic and continental areas compare as to temperature in winter and summer?

Find the place and range of the heat equator. On blank outline maps of the world plot its January, July, and average position.

Follow the isotherms passing through New York (January, July), and note the regions through which they pass. What great cities near them?

Summary of facts to be made in class according to the following heads:

Relation of parallels of latitude and isotherms in northern and southern hemispheres.

Comparison of isotherms over land masses and water. For January; for July.

Comparison of east and west side of continental masses. Make comparison along the parallel of 40° N. Lat. and S. Lat.

Comparison of isotherms of northern and southern hemispheres in January and July.

Migration of temperature belts, and relation to earth's position in reference to sun.

References.

Davis, *Physical Geography,* pp. 22–29.

Tarr, *Elementary Physical Geography,* pp. 43–67; *First Book of Physical Geography,* pp. 55–84.

Hinman, *Eclectic Physical Geography,* pp. 58–64.

Ward, *Practical Exercises in Elementary Meteoroiogy,* pp. 51–61.

Mill, *The Realm of Nature,* pp. 129–133.

Atmospheric pressure.

Introductory. — Measurement.

Method employed — barometric readings — when taken — reduction to sea level.

Determination of altitude by means of barometric pressure.

Computation of height of atmosphere.

Relation of temperature to pressure.

Expression of pressures by isobaric lines.

Laboratory study of isobaric surfaces and lines.

Variation of atmospheric pressure from the normal isobaric pressure of 30 inches at sea level.

Taking a horizontal line as *sea level,* at which all barometric readings are taken, plot the warping of the 30 inches isobar from some low to some high pressure area. Select some weather maps with a good low and high pressure area, and take some readings of each isobar between the two centres.

Take 5 mm. for every .1 inch above.
Take 1 mm. for every .1 inch below.

Plot by lines the distribution of pressure in the United States for days whose temperatures have previously been studied. Use blank United States weather maps.

Place by each station mentioned the barometer readings for that place.

Draw a line connecting all places having the same barometric conditions, e.g., a pressure of 29.90 inches. This is the isobar of 29.90.

Draw isobars for every even one-tenth inch, estimating the position of a line where the readings are not in even one-tenth inches.

State the facts of distribution of pressure as shown by the arrangement of isobars.

Describe the difference in arrangement of isobars and isotherms.

Find the regions of lowest and highest barometer. Mark these areas "low" and "high," respectively.

Color brown all regions where the pressure is below 29.90; color red all parts having a pressure above 30.00.

Compare your map with the United States map for the same day; make any necessary corrections.

Study a series of maps covering a week's record. Note the changes in pressure distribution. What becomes of the "highs" and "lows"? Do they take any one general direction across the country?

General distribution of pressure over the earth. Study the January and July isobaric charts of the world.

Examine each chart separately, then compare the January and July charts with one another.

Find the regions of highest and lowest barometric pressure, and note their general location.

How do the areas of low and high pressures compare with the temperature belts previously studied? Do the facts agree with the prophecies made during that study?

Summary of facts to be made in class, according to the following heads:

Warping of isobars.

Change from summer to winter, over land and over water.

Comparison in relative amount of warping in northern and southern hemisphere.

Location of areas of maximum and minimum pressure.
For summer; for winter.
Migration of belts of maximum and minimum barometric pressure.
Relation of isobars to isotherms.
References.
Tarr, *First Book of Physical Geography,* pp. 85–90.
Hinman, *Eclectic Physical Geography,* pp. 78–81.
Ward, *Practical Exercises in Elementary Meteorology,* pp. 76–85.
Mill, *The Realm of Nature,* pp. 134–135.

Circulation of the atmosphere.
Introduction.
Winds. — What are the winds? — Direction of motion.
Method of observation, measurement of velocity, classification according to velocity, etc.
Winds consequent upon a rotating planet (planetary).
Trades; prevailing westerlies; doldrums; horse latitudes; upper currents.
Location and characteristics of each belt; seasons and character of life in each area.
Relation of wind belts to isobars and isotherms.
Winds consequent upon a planet inclined 23½° in its axis (terrestrial).
Seasonal changes. Shifting of calm belts — consequent disturbance of path of winds — effect of earth rotation.
Winds consequent upon distribution of land and water (continental).
Continental winds. Importance in New York City.
Monsoons.
Winds consequent upon diurnal conditions.
Mountain and valley breezes.
Land and sea breezes.
References.
Davis, *Physical Geography,* pp. 29–45.
Tarr, *Elementary Physical Geography,* pp. 68–84; *First Book of Physical Geography,* pp. 90–102.
Hinman, *Eclectic Physical Geography,* pp. 78–89.
Mill, *The Realm of Nature,* pp. 116–122.

Moisture in the atmosphere.
Source — evaporation.
Capacity of atmosphere for moisture. Dew point — relative degrees of saturation — cause of precipitation.
Transportation of moisture by prevailing winds.
Measurement of humidity.
Forms of moisture in atmosphere.

Dew.
Frost.
Hail.
Snow.
Clouds.
Forms and causes.
Causes of precipitation. Influence of highlands upon precipitation.
Relation of precipitation to storms.
Storms of the westerly wind areas.
Control of the weather by storms.
Characteristics as to temperature, pressure, cloudiness, rainfall.
Path and rate of progress.
Hot and cold waves, northers, blizzards, etc.

Laboratory work.
Study of winter storms of the United States, from selected series of United States weather maps.
Describe the distribution of winds about the centre of a cyclonic or low-pressure area. What is the general direction of winds about an anti-cyclonic or high-pressure area? Average direction of winds in each quadrant for a series of storms.
In what quadrant of the storm area do you find clouds and rain? Do you find snow in any part? Where is the clear weather?
Note the general direction of the isotherms in a low-pressure area. Explain the warping of these lines. How do the high-pressure areas differ in this respect?
Using the maps in the *Monthly Weather Review,* find the distance travelled by a storm, in miles per hour. Find the highest, lowest, and mean velocity.
References.
Davis, *Physical Geography,* pp. 48–50.
Tarr, *First Book of Physical Geography,* pp. 102–121; *Elementary Physical Geography,* pp. 93–104.
Hinman, *Eclectic Physical Geography,* pp. 90–97.
Ward, *Practical Exercises in Elementary Meteorology,* pp. 85–124.
J. M. Jameson, "Elementary Meteorology," *Journal of School Geography,* January, February, March, and April, 1898.

Rainfall.
Method of recording amount.
Study of distribution from rainfall chart for the world.
Relation between general system of winds and calm belts and rainfall.

Equatorial rains; influence of highlands, deserts.
Trade wind belts and trade wind deserts.
Horse latitude belts — little rain.
Westerlies; effect of barriers upon rainfall.
Study distribution of rainfall in United States, using rainfall model and rainfall charts for the following regions, stating maximum and minimum, and trying to give causes for variable amounts.
Atlantic coast.
Gulf coast.
Lake region.
Mississippi Valley.
Great Plains.
Rocky Mountains.
Great Basin.
Sierra Nevada and Coast Ranges — contrast north and south.
Relation of rainfall to interests of man.
Agriculture. (Discuss value of irrigation.)
Forestry.
Manufactures.
Commerce.
References.
Davis, *Physical Geography*, pp. 45–47.
Tarr, *First Book of Physical Geography*, pp. 144–148; *Elementary Physical Geography*, pp. 114–123.
Hinman, *Eclectic Physical Geography*, pp. 76–77.

Summary of weather and climate.
Weather.
Characteristic summer and winter weather of eastern United States.
Study weather signals employed by United States Government.
Climate.
Relation of weather to climate; most important climatic elements.
Climates of the different zones.
Subdivisions according to varying character of different portions — land and water, coasts and interiors, mountain and plateau.
Dominant climatic features of these subdivisions.
Seasonal conditions; effect upon life.
General relation of climate to vegetation, animals, man.
References.
Davis, *Physical Geography*, pp. 52–56.
Tarr, *First Book of Physical Geography*, pp. 149–164; *Elementary Physical Geography*, pp. 124–134.

Ward, "Climatic Notes Made During a Voyage Around South America," *Journal of School Geography*, September and October, 1898.

Equipment available for studying weather and climate.
- Maps and atlases.
  - Daily United States weather maps.
  - Series of old weather maps selected and mounted on cards.
  - *Monthly Weather Review* maps.
  - Bartholomew's *Atlas of Meteorology*.
  - Wall maps, enlarged from small-scale atlas maps, showing,
    - Rainfall of world.
    - January isobars.
    - July isobars.
    - January isotherms.
    - July isotherms.
  - Mounted records of barograph and thermograph for a year.
  - Large series of diagrams copied from standard works on meteorology.
- Models.
  - Howell's model, showing rainfall of United States.
- Instruments.
  - Dry bulb Weather Bureau standard thermometer.
  - Wet bulb Weather Bureau standard thermometer.
  - Maximum Weather Bureau standard thermometer.
  - Minimum Weather Bureau standard thermometer.
  - Weather Bureau standard barometer.
  - Richard Frères barograph.
  - Richard Frères thermograph.

## *The Land*

General features of the earth's surface.
- Distribution of land and sea.
  - Determination of land and water hemispheres.
  - Contrasts in land and water areas in their effect upon life.
  - Extent, outlines, grouping of continental masses.
- Representation of earth's features on flat surface.
  - Elements of map projection — stereographic, conic, and Mercator; projections compared; advantages and uses of each.
  - Representation or relief — hachures, shading, contour.
- Laboratory work.
  - Study of simple topographic maps of the United States Geological Survey, e.g.:

Marthas Vineyard sheet (2 periods).
- Find the latitude and longitude of the locality.
- Note the location of railroads, roads, houses, town. Why located in these places?

Find the highest point, lowest area, gentlest slope. Find the difference in elevation of the two highest points and how far apart they are. Could one be seen from the other?
Find a hill, valley, promontory.
Determine the best bicycle road between two selected places, and determine the distance by road between them.
Work out the horizontal scale of the map. What is the length of the island?
Make a cross section from Oyster Pond across Indian Hill. What is the vertical exaggeration in your section? Use 1-10 inch to represent every 20 feet of elevation.

Characteristics of the land.
Varieties of land surface.
Climate and activities of the lands.
Relation of the physical conditions of the lands to life.
Relation to distribution of animal and plant life.
Influence upon human life.
Contrasts in effect upon savage and civilized races.
The rocks of the earth's crust.
Strong rocks, or ridge and highland makers.
Weak rocks, or valley and lowland makers.
The origin and position of rocks in earth's crust.
Crystalline rocks, and their effects upon topography.
Stratified rocks, and their effects upon topography, as determined by their relative strength.
Changes in original land forms.
Erosive processes.
Agents of erosion and transportation — mode of action; effect of character of rocks; vigor of force, etc.
General result of erosive processes; life cycle, young, mature, and old land forms.
Deposition of waste.
Laws governing deposition.
Some important results — formation of deltas, bars, continental shelf; construction of alluvial fans, alluvial plains; lake filling, valley filling.
References.
Davis, *Physical Geography,* pp. 99–100, 103–105, 267.
Tarr, *Elementary Physical Geography,* pp. 205–207; *First Book of Physical Geography,* pp. 240–260.

Typical land forms.
Plains.
Young or constructive plains.
Coastal plain.
Origin and structure.
Characteristics.

Form and surface; accordance of surface with structure; character of rocks and soils.
Character of shore line — at first; change by addition of sand reefs, etc.
Drainage and dissection.
Base level — control of drainage.
Relation of dissection to drainage.
Water supply — artesian wells; conditions necessary.
Fall line — how formed; location on Atlantic border; importance.
Influence upon life of man.
Location of villages, roads, etc.
Relation of back country to plain; commercial relations; harbor facilities.
Stages in development or "ages" of coastal plain.
The geographical cycle.
Youthful stage — characteristics; culture relations.
Mature stage — aspects; characteristics; relation to life.
Approach to old age. Compare with characteristics and culture relations of mature stage.
Old age. Contrast with youthful stage; points of similarity.
Classes of coastal plains.
Narrow and broad coastal plains.
Characteristics of each. Compare forms, surface, drainage, coast line, culture relations. Reasons for differences.
Embayed coastal plains.
Characteristics; previous condition; reasons for present aspect; relation to life of man.
Belted coastal plain.
Structure; characteristics.
Peculiarities of dissection, drainage, and distribution of uplands and lowlands.
Coastal plain of New Jersey (considered as a type).
Extent and relief; significance of slight relief.
Structure — surface — location of uplands and lowlands, direction of highest highland; soils — kinds and distribution.
Drainage — size, vigor, direction, work. Why are the valleys of the westward flowing "creeks" deeper than the seaward flowing "rivers"?
Coast line — characteristics; lagoons, "thorofares," beaches.
Relation to man's life — location of industries, commercial centres, railroad routes, etc.
Reasons for conditions.

Maps and models to illustrate topics under coastal plains.
- Models.
  - Mountains bordering the sea. Harvard models. W. M. Davis and G. C. Curtis.
  - Narrow coastal plain. Harvard models. W. M. Davis and G. C. Curtis.
  - Geological model of State of New Jersey. New Jersey Geological Survey.
- Maps.
  - Topographic atlas of United States. Folio I, Physiographic Types, Plates I–III.
  - Grouped contour map sheets:
    - Ocala and vicinity, Fla. United States Geological Survey.
    - Southeastern New Jersey. United States Geological Survey.
    - Maryland, Chesapeake Bay region. United States Geological Survey.
    - Glassboro, N. J. United States Geological Survey.
  - Maps and illustrations. Reports of New Jersey Geological Survey, 1895–1898.

Laboratory work under general study of coastal plains.
- Notes on method of studying a map.
- Notice:
  - Scale; contour interval.
  - Character of surface — contour lines near together or widely separated; general elevation of region.
  - Relief — small or great; localized or not.
  - Dissection — much or little.
  - Drainage.
    - General development — presence or absence of lakes, etc.
    - Direction, arrangement, activity of streams (the latter seen by relation to master stream.)
  - Culture features.
    - Roads — direction, relation to topography.
    - Railroads — course, grade, costly to construct or not.
    - Place of houses — relation to drainage and relief.
    - Towns — number, size, probable reason for location.

Detailed examination of special features illustrated by map and designated for study.
- Grouped contour map sheets. — Ocala and vicinity, Florida.
  - Note general relief; character of surface. Does this region differ as to form from other regions studied?
  - Note whether or not the drainage is definite. How account for facts? Give reason for opinion.
  - Study areas of depression located 100 or more feet above sea-level. Account for them, if possible.
  - What is true concerning location and direction of roads, rail-

roads, and towns? What inferences may be drawn from these facts?

Contour map. — Glassboro, N. J. (An example of a coastal plain, partially dissected.)

What is the greatest altitude found in the northern part? In the southern part? Where found?

Compare the altitude and relief.

Describe the topography of the country represented in Sections 5 and 9.

Account for the course of Raccoon Creek; of Maurice River; of the tributaries of these streams.

Using the 100-foot contour line as a boundary, note and describe the valley of Raccoon Creek; of Maurice River.

Find the amount and grade of descent of each of these streams. Can you account for the difference?

Make two cross sections of the map — one cutting through the deepest part of Maurice River valley, the other cutting through the deepest part of Raccoon Creek valley.

Note and explain the course of roads and railroads, the scarcity of towns, the apparent insignificance and the distribution of the few found.

Describe the path of and the view to be seen from the Western Jersey Railroad, from Franklin to junction southwest of Newfield; from the Philadelphia & Reading Railroad from Five Points to Mullien Hill. What high points would you see, and how would the country look?

Laboratory work on classes of coastal plains.

Embayed coastal plain. (Grouped sheets of Chesapeake Bay region, Maryland.)

Study relief, drainage, dissection.

How do you account for the irregular shore line? Note particularly the region of Nominee Cliffs.

Reconstruct the history of this section of country.

Compare statements on p. 131 of text book (Davis, *Physical Geography*) with facts of the map. In what ways is geographic control strongly shown in this region?

Belted coastal plain. (Grouped sheets of southeastern New Jersey region.) Relief maps in *Report of New Jersey Geological Survey,* 1895; relief model of State of New Jersey (geological).

Compare with Florida map in general relief and character of surface; definiteness of drainage; control of location and direction of roads and railroads; position of towns. Reason for opinions.

Note what areas would remain above sea-level if New Jersey should sink 50 feet; 100 feet.

Note the names given to streams on the western side of the

plain; on the eastern. What difference in size, vigor, direction?

What does the straight line of land back of the lagoon and marsh area indicate? Reasons for answer.

What names are given to the waterways among the marshes bordering the lagoons? Why so named?

How does the route of the Camden, Atlantic & Philadelphia Railroad differ from that of other railroads? Reasons for this route.

Special topics. — Illustrative work in connection with study of general characteristics of coastal plains.

Make a diagram showing the conditions present in a region where a "fall line" exists. Number important points, and explain their relation to one another. Davis, *Physical Geography*, p. 128.

Show by diagram the structure suitable for the construction of "artesian wells." Explain why such wells may be made on off-shore sand reefs; on ancient coastal plains. Davis, *Physical Geography*, p. 127.

Individual work in connection with study of broad and narrow coastal plains.

Compare narrow and broad coastal plains in general characteristics and in culture features.

Draw a rough sketch map of that portion of the coastal plain of the Carolinas shown on p. 24 of Davis's *Physical Geography*. Using a suitable scale of miles, from information given in the text, indicate belts, elevation of inner margin of each, kinds of soil, productions. Locate on this map cities situated on the "fall line."

References for reading upon which special reports were made:

"Characteristics of Coastal Plain of South Carolina." Glenn, South Carolina, *Journal of School Geography*, January and February, 1898.

"General Features of Coastal Plain of North Carolina." Cobb, North Carolina, *Journal of School Geography*, November and December, 1897.

The New Jersey coastal plain given as a problem to be worked out individually. (Preceding study of coastal plain of New Jersey.)

From study of model and text, find what features are like plains already studied; what features different from those previously considered.

What peculiar and (so far) unusual drainage conditions are found? What explanations may be suggested? (Recall Raccoon Creek and Maurice River on Glassboro map).

Under what class given in the text book should this plain be placed?

Why?
References for study of New Jersey coastal plain.
Davis, *Physical Geography,* pp. 113–116.
Salisbury, *Reports of Geological Survey of New Jersey,* 1895, pp. 57–64; 1898, p. 185, etc.

Alluvial or flood plains and lake plains.
Flood plains — mode of formation; characteristics; relation to life of man. Comparison with coastal plains.
Lake plains — formation — filling up, swamping, draining; characteristics; culture relations. Comparison with flood plains and coastal plains.
Reference.
Davis, *Physical Geography,* pp. 278–288, 340.
Maps used to illustrate topics and for laboratory work under flood plains and lake plains.
Contour map — Fargo — James River region, North Dakota. United States Geological Survey.
Grouped sheets — Donaldsonville and vicinity, Mississippi River delta. United States Geological Survey.
Large map of alluvial plain of Mississippi River from mouth of Ohio to Gulf. Mississippi River Commission.
Old plains of erosion.
Terms — peneplain, monadnocks.
Contrasts with constructive (young) plains.
Characteristics; effect of uplift. How old plains differ.
Drainage — comparison with that of young plains.
Culture relations; effect of change of base level.
Reference.
Davis, *Physical Geography,* pp. 189–195, 152–155.
Plateaus.
Young plateaus (Arizona as an example).
Structure; character of surface. Compare with plains.
Dissection and drainage.
Characteristics; arrangement of drainage lines.
Evidence and results of erosion — canyon walls, cliffs, and talus slopes; falls and their extinction.
Effect of climate.
Relation of man to young plateaus —effect of aridity; habitability of region; barrier to travel.
Illustrative material.
Pictures and maps in Dutton's *Tertiary History of the Colorado Cañon.*
References.
Davis, *Physical Geography,* pp. 141–146.
Gannett, *North America.* "Description of Colorado Cañon."
Russell, *Rivers of North America,* pp. 271–275.
Individual work.

Make a diagram showing the process of retreat and extinction of falls in a canyon. Number important points and explain their relation to one another.

Reference.

Davis, *Physical Geography,* p. 144.

Dissected plateaus. (Type — Cumberland, Allegheny, Catskill plateaus.)

Characteristic features.

Dissection and drainage.

Remnant "mountains." — How formed.

Culture relations — man's life and industries. Why are coal and iron mines in the valleys instead of on the uplands?

Illustrative material.

Map and model of Catskill and Chattanooga region. Sewanee and Buckhannon Folios. United States Geological Survey.

References.

Davis, *Physical Geography,* pp. 146–150.

Ellen C. Semple, "Influence of the Appalachian Barrier upon Colonial History," *Journal of School Geography,* February, 1897.

Old plateaus. (New Mexico as an example.)

Peculiarities of surface; character of drainage.

Mesas and buttes — how formed; relation to former height of plateau.

Relation of old plains to old plateaus.

Relation to man's life; old civilizations of mesas of North America.

References.

Davis, *Physical Geography,* pp. 150–152.

Hodge, "The Enchanted Mesa," *Nat. Geog. Mag.,* Vol. VIII, p. 273.

Broken plateaus. (Colorado plateaus as a type.)

Character of surface; relation of blocks; evidence of original continuity of surface.

Fracturing and faulting; fault cliffs.

Drainage and dissection.

Relation to life of man.

Reference.

Davis, *Physical Geography,* pp. 155–158.

Special topics.

In what way are young and dissected plateaus alike? How are they unlike?

Contrast the life features in each. What are the peculiarities of the inhabitants of each?

Describe the chief characteristics of the Catskill, Allegheny and Cumberland plateaus.

Give the origin of the uplands on an old plateau.

Laboratory work in connection with study of plateaus.
- Colorado Canyon map, composed of mounted topographic sheets of the United States Geological Survey.
  - What is the general character of the streams of this region as to arrangement and relation to relief?
  - Note the contour lines. What indication do they give that this is a plateau region?
  - Notice the shape and position of mesas and buttes. What story do they tell concerning events in this region?
  - What indications of man's presence in this desert country? Account for the location of such features.
- Catskill model and map.
  - Under what land form would you classify the Catskill Mountain region? Reasons.
  - Contrast the quality of slope and character of drainage of the upland surface with that of the escarpment.
  - What unusual features of drainage do you discover? Study drainage between Catskill Mountains and Hudson River. Note particularly the region about head waters of the Plaaterskill and Kaaterskill. Can you trace the history of these streams?
  - Note roads and railroads and account for their position. Explain the position of the road from Woodstock to Platt Cove.
  - Study the culture features represented in Kaaterskill Cove. What evidence of geographic control?
- Virginia and West Virginia map.
  - Study amount and character of upland surface; character and position of divides and streams.
  - How do the facts shown on map compare with the statements in Davis, *Physical Geography,* pp. 147–149?

Mountains.
- Block mountains.
  - Young stage. (Southern Oregon as a type.)
    - Character of ridges; evidence of change from plains to mountains.
    - Drainage and dissection — character and direction of streams; contrasts in dissection of different portions; effect of climate; formation of alluvial cones and talus slopes.
    - Earthquakes and hot springs — significance.
    - Relation to life of man.
  - Dissected block mountains. (Utah and Nevada as types.)
    - Characteristics — compare ridges with those of young "block mountains."
    - Effects of dissection — change of form; accumulation of detritus in troughs, on mountain flanks.

Climatic features — contrasts between mountain tops and valleys; aridity shown by streams.
Effect of geographic features upon life of man.

Laboratory work in connection with study of block mountains.
Grouped sheets — Great Salt Lake region.
Note the relief and the arrangement of contour lines. What points would suggest "block mountains"? In what stage of development?
Examine carefully Sevier Desert, Rush Valley, Skull Valley, Round Valley. Give conclusions as to aridity of regions.
How do roads, railroads, and settlements show geographic control?
Grouped sheets — Lake Tahoe region. (Example of dissected block mountains — desert conditions.)
Study the contour lines of valleys and adjoining mountains. Account for differences.
How does the direction of drainage in valleys differ from that in the mountains near? Explain. What peculiarity of many of the streams? Reason. What evidence that water of the region evaporates, leaving saline deposits?
Account for the position of roads and settlements.

Folded mountains. (Jura Mountains as a type.)
General form. Terms — anticline, syncline, trend, dip, strike, escarpment.
Structure — evidence of origin.
Drainage; direction; effects — process by which crests of folds are worn down and streams captured and beheaded. Formation of synclinal mountains and anticlinal valleys.
Relation to man — place of settlements, roads and farms.
Domed mountains. (Black Hills as an example.)
Form and structure.
Dissection and drainage — relation of drainage lines to original slope of surface; relation of rimming ridges to central mass.
Culture relations — mineral resources; industries.

Laboratory work in connection with folded and domed mountains.
Model and map of Chattanooga region.
How would you classify Sequatchie Valley? Reason for decision.
Classify Walden Ridge, Sand Mountain, and similar elevations. Why thus classify them?
Can you discover any reason for the location of Chattanooga?
Map of region of Henry Mountains.
Note the direction of contours and of drainage lines. Com-

pare with those on maps of Great Salt Lake region and Lake Tahoe region. Conclusions.

What suggestion does the map give you that this is a region not attractive for settlement?

Massive or lofty mountains.

Complexity of structure.

Drainage and dissection — resulting forms — peaks, ridges, valleys.

Mountain phenomena — earthquakes, avalanches, glaciers.

Embayed mountains.

Characteristics; compare with embayed coastal plain.

Relation to man's life. Why should such a region be less habitable than in its former condition?

Geographical relations of mountains.

Climate of mountains.

Mountains as barriers.

Character of inhabitants of mountains.

References.

"Development of a Mountain System." Tarr, *First Book of Physical Geography*, p. 337.

Davis, *Physical Geography*, pp. 167–171, 172–175, 179–180, 195–196, 175–179, 183–184.

Special topics (for individual work).

Products of worn down mountains. Reference, Davis, *Physical Geography.*

Mountain inhabitants; "stranded" races — their customs and languages. References, Davis, *Physical Geography*; Taylor, *Words and Places.*

The Piedmont belt south of New England. Reference, Davis, *Physical Geography.*

The New England upland. References, Davis, *Physical Geography; National Geog. Monographs — Physical Geography of Southern New England.*

The Scottish Highlands and their inhabitants. Reference, Davis, *Physical Geography.*

The Baraboo ridge, Wisconsin. Reference, Davis, *Physical Geography.*

Field work. Morningside Heights, 120th St. to 123rd St.

Nature of rock.

Dip and trend. What culture feature seems to be largely traceable to these two things?

Erosion. What agents seem to be most active? Give proofs.

Signs of glacial action. Make a list of all that you find. Conclusions.

Topography of upper New York as seen from the Heights. Describe briefly. What problems are presented by the presence of the historical "Hollow Way" — the lowland in which the Fort Lee Ferry landing lies?

Study the general geographic relations of this part of New York and name the features which seem to you the most important or controlling features of the region.

Volcanoes.
- Distribution.
  - Significance of location.
- Young volcanoes.
  - Form and structure of volcanic cones.
  - Phenomena of eruption; effects.
  - Lava flows; nature and effects.
  - Formation of calderas.
- Dissected volcanoes.
  - Characteristics.
  - Drainage; arrangement and character of streams.
  - Dissected lava plateaus.
- Worn down volcanoes.
  - Volcanic necks and dikes.
  - Lava "table mountains" or mesas.
  - Culture relations.

Study of contour map. Mount Shasta sheet. (Laboratory work in connection with general study of volcanoes.)
- What features shown on the map would indicate that Mount Shasta is a volcano?
- Describe the drainage of the cone.
- What are the sources of Whitney, Bulam, and Mud Creeks? Where else do you find something similar?
- In how many places can you find evidence of falls? What is the probable cause?
- What is the character of the country where the greatest number of intermittent streams are found?
- What is the probable origin of the Shasta valley?
- What is the cause of disappearance of streams at the base of the cone?
- Is there evidence of streams originating at base of cone? Reason. (Note Big Springs.)
- What is the probable origin of the swamps and lakes in this region?
- Make a cross section of Mount Shasta, from intersection of 5000-foot line with eastern border of map to a point on the 4000-foot line, exactly east of Boles Creek, horizontal scale as on map; vertical 1-10 inch to 2000 feet.

Certain great agents of topographic modification.
- Rivers.
  - Ground water.
    - Source.
    - Movement of water underground.
      - Important effects; caves, springs, geysers.

Life history of rivers.
Young rivers.
Characteristics; activities.
Lakes; how formed; effects.
Falls and rapids; cause, effect on development of stream valley.
Relation of man to young rivers.
Mature rivers.
Process of development.
Grading of course.
Development of meanders, broad valleys, and flood plains.
Old rivers.
Necessary conditions; characteristics.
Why is it unusual to find an *old* river system?
Revived rivers.
Cause of revival.
Important effects — narrow gorges in valley floors.
Relation to life of man.
Dismembered rivers and drowned valleys.
Contrast conditions of formation.
Compare results — on land forms; use to man. Why should dismembered rivers form good harbors?
Noted examples.
References.
Davis, *Physical Geography,* pp. 222–262.
Tarr, *First Book of Physical Geography,* pp. 261–293; *Elementary Physical Geography,* pp. 262–289.

Glaciers.
Existing ice sheets and glaciers.
Continental, valley, piedmont glaciers. Locate examples.
Formation of glaciers — conditions necessary; structure of different parts; cause of variation in length of glacier.
Formation of ice falls and crevasses — relation to character of bed; compare with stream action.
Mode of erosion and transportation and deposition of waste.
What are the sources of the transported material?
Where and how transported? How does the glacier wear its bed?
Compare with erosion and transportation by river.
Moraines — lateral, medial, ground, terminal.
Formation and characteristics of each.
Features of drumlins, eskers, kames.
Ancient glaciers and ice sheets.
Glacial period — meaning of the term.
Effects of glacial period.
Formation of valley flood plains. Explain diagram on p. 333, Davis, *Physical Geography.*

Formation of lakes in river valleys.
Terminal moraine; effect on landscape.
Ground moraine — character of material; usefulness of this soil.
Diverted rivers; rapids and waterfalls; divides formed by glacial material.
Why are most of these effects of great importance to man?
Contrast of central glaciated area of America with regions south.
References.
Davis, *Physical Geography,* pp. 324–346.
Tarr, *First Book of Physical Geography,* pp. 294–312; *Elementary Physical Geography,* pp. 306–327.

Laboratory work. Study of Heim's model of a glacier.
Note the location of tributary glaciers and study their relation to the main glacier.
Account for the different ways in which the small ice streams at right and left of main tributaries enter the main body of the glacier.
Study the arrangement of moraines. Account for their grouping just above the longest ice fall. Can you find any traces of a terminal moraine? If so, note its position and extent.
Study crevasses and seracs and account for their position.
Note the extent of separate glaciers. Why does the main one reach farther down the valley than the others?
Study of maps of glaciated region.
Maps: grouped sheets — Sun Prairie, Wis.; Central Massachusetts, Boston Harbor.
Study the effect of glaciation upon drainage. Can you find any streams whose courses have been diverted? Where?
Note the number and distribution of small lakes. Can you suggest their origin? What is the cause of the various swamps near the lakes, or existing independently?
What would you suggest as a cause for the numerous islands of similar shape in Boston Harbor? Why are some of them apparently wasting rapidly?
Field work. Staten Island, South Beach.
Study on the beach the examples in miniature of an initial stage of a coastal plain.
Notice the action of wind upon the sand above high tide line. If the forms thus made could be covered and preserved, what facts could be read from them in future time?
Study the lagoon formation and note how the land area has been extended and is increasing.
Walk from beach to moraine.
Note the changes in character of deposits as you move inland. Explain.

Make a note of the features that you consider most distinctively morainic and give reasons for your choice.
What evidence that this is the work of ice — of a glacier?
What agents other than glacial have been at work here? What have they done?
What facts go to show that the glacier was moving in a general southerly direction? (Use observations made on the way from the beach to the moraine).
What have been the effects of this glacial deposit upon the life of the vicinity?
Can you discover any reason for the location of the small factory seen in the distance?

Bronx Park.

Compare the two portions of the stream valley (valley of the Bronx River) and account for their present aspect.
Where is erosion most active? Where is deposition in rapid progress?
What problems are presented by the presence of the large pot holes found in the rocks far above and at a distance from the stream? Give your own explanation.
If the dam near the old mill should be removed, what would be the effect upon the stream and its surroundings?
Is there any evidence of glacial action to be found in this region? Compare with evidences found elsewhere.
How is geographic control shown in the culture features of this vicinity?

## *The Oceans*

Erosive work of the ocean.

Read the statements on pp. 347–348, Davis, *Physical Geography,* concerning the interaction of destructive forces at work upon land forms. Why does not the land area become greatly reduced?

Shore lines.

Meaning of terms shore line and coast?
Upon what does original outline of coast land depend?
Classification of shore lines.
Number of classes — how produced; characteristics.
Elevated shore lines; shore lines of the first class.
Characteristics.
Changes effected by the ocean.
Sand reefs — formation; advance and retreat.
Inlets — relation to coastwise traffic; tidal deltas.
Effects of depression and elevation upon this class of shore lines.
Characteristics of new shore line in each case.
Effect upon life of man.

Depressed or drowned shore lines — shore lines of the second class.
General characteristics; relation to man's life.
Changes effected by the ocean.
Formation of sea cliffs and benches; sea caves.
Formation of bay head beaches and retreat of sea cliffs; formation of barrier beaches and general retreat of shore line — effect of strong tides.
Land tied islands — process; importance to man.
Effect of elevation and depression upon drowned shore lines.
Characteristics of new shore lines; culture relations.

Questions for review.
What features would you expect to find on a shore line of elevation? Name some changes that lapse of time brings about. Of what use to man are these forms?
How would you know a depressed shore line? What changes does time make upon it? What relation have these forms to man's life?
Describe the formation of bay head beaches and barrier beaches.

Laboratory work. Study of Heim's model of shore features.
Study the contrasts of shore topography. Note the points of attack and of deposition, and study the results of each kind of work.
Compare the various beaches and explain their origin.
Can you find any evidence of uplift? Study the relation of outstanding islands to the shore. What facts in their history are suggested?
Compare the past and probable future history of the lagoon between the two bold headlands at the left of the model with that of the lagoons back of the sand dunes at the right of the model.
How is geographic control over man's life shown on this model?
Grouped contour sheets — New Jersey and Massachusetts coast.
Massachusetts coast — Provincetown peninsula.
Study the region from Highland Light northward. Where can you find evidence of attack by the sea? Of deposition? Contrast the outside and inside coasts of the peninsula.
Note the hooks and spits along the ocean side of the peninsula. From whence is the material for their formation derived?
In what localities do you find cliffs? Where are they protected? Where now being cut? Why should the long straight eastern shore be called the "graveyard of the Cape"?

What do the roads and railroads suggest concerning the character of the country?

New Jersey coast.

Note the relation of Sandy Hook to the mainland. Compare the inner and outer shores and account for conditions found. Compare with Provincetown peninsula.

Study carefully the cliffs, spits, hooks, sand bars, lagoons, and "thorofares." What formations are dependent one upon another, and how? Compare with Massachusetts coast.

Where on the coast do you find protected cliffs? Where are cliffs or beaches being attacked by the sea? What conditions are like those shown on Provincetown map?

Is there any evidence that this region has been recently elevated? If so, where? What are the evidences of depression?

How do the culture features show geographic control?

References.

Davis, *Physical Geography*, pp. 347–383.

Tarr, *First Book of Physical Geography*, pp. 313–331; *Elementary Physical Geography*, pp. 328–349.

Form, divisions, and general characteristics of the ocean.

Essential continuity and uniformity.

Depth, composition and density, temperature.

Where are the greatest depths found?

What reasons are there for the nearly uniform density of the ocean throughout its entire depth?

Account for the great variety of substances found in ocean waters.

What reasons may be given for the low temperatures of the ocean depths? For the small range of temperature at the surface?

What proofs may be given of interchange between polar and equatorial waters?

Divisions of oceanic areas.

Great oceans; depth and volume compared with extent and elevation of land surface.

Mediterranean — relation of important ones to continental masses; significance of temperature peculiarities.

Submerged continental shelves — relation to continental masses.

The ocean floor.

General character. Compare with land surface.

Sediments — origin and characteristics.

Character and distribution of life in the ocean.

What are the characteristics of life in the surface layers? In the deep sea?

What comparisons may be made between life in the ocean and upon land?

Movement of ocean waters.
- Waves.
  - Cause; characteristics of wave movement. What proof may be given that the wave form and not the water moves onward? Explain the use of oil to reduce the violence of storm waves.
  - "Swell" and "surf": causes; effects.
  - Earthquake waves.
    - What cause, other than volcanic eruptions, sometimes produces these waves?
    - Describe and account for their very destructive effects.
- Currents.
  - Causes; proofs of control by prevailing winds; direction and rate of movement; "drifts" and "streams." Why is a knowledge of the movements of currents important in navigation? What interesting indications of the movements of currents have been noted? (See Davis, *Physical Geography*, p. 79).
  - Important currents; oceanic eddies; branch currents or "streams"; relation of currents of Indian Ocean to monsoons. (Read pp. 42, 43, 80, Davis, *Physical Geography.*)
  - Influence of oceanic currents upon temperature — temperature of the Atlantic; effect upon life of man.
- Tides.
  - Characteristics of tidal movements.
    - Flood and ebb tides; effect of land; range of tide in bays.
    - In what ways do tides resemble waves?
  - Cause of the tides.
    - What reasons for connecting tidal movements with the moon?
    - Study the "tidal problem," pp. 406–407, Davis, *Physical Geography.*
  - Importance of tides.
    - Why beneficial in bays and harbors?
  - Peculiar tidal phenomena.
    - Bores; tidal races.
    - Spring and neap tides.

Questions for review.
- What are the tides? How often do they occur? Describe the phenomena briefly.
- Contrast the conditions as to tidal waves in open ocean and in bays.
- Compare tides and waves.

References.
- Davis, *Physical Geography*, pp. 57–90.
- Tarr, *Elementary Physical Geography*, pp. 151–203; *First Book of Physical Geography*, pp. 187–219.

*The Earth and Man.* (A Summary and Review.)

Civilization as related to environment.
- Barbaric races. Control exercised by environment strong.
- Civilized peoples.
  - Control of the past.
  - Control of the present — less marked. Ability to overcome existing conditions.
  - Travelling across the continent to-day compared with difficulties encountered half a century ago.

Relation of surface features to man.
- Mountains — barriers due to trend, steep slopes, lack of water, rarity of air.
  - Effect of barriers upon the settlement of a country, e.g., influence of the Appalachian barrier upon the settlement of the United States.
    - Determined lines of settlement.
    - Directed and limited immigration and migration.
    - Strengthened early settlements.
    - Offered protection from enemies.
  - Dangers arising from a sharp line of demarcation between a people.
    - Relation of pioneer settlements of Mississippi valley to Atlantic States.
  - Effect of barriers upon the development of a region.
    - Growth checked through limitation of boundaries. Newburg and Fishkill compared.
  - Effect of mountains upon life of people.
    - Characteristics of mountain dwellers — Scotch, Swiss, etc.
    - Differences in a people arising from separation of valleys — e.g., clans of Scotland.
    - Slow development of isolated mountain dwellers. Mode of life of the natives of the mountains of Tennessee and Kentucky. Industries of the home — method of trade, etc.
    - Influence of mountains upon industry.
- Valleys.
  - Gateways for exploration.
  - Regions of early settlement. Compare the settlement of the Mohawk and the Hudson valleys with that of adjacent mountains and plateaus.
  - Importance commercially — e.g., Hudson and Mohawk valley a great factor in determining the supremacy of New York City.
  - Highways of travel.
- Plains.
  - Seat of early civilizations, e.g., Chinese — developed in river plains of China. Hindus, in plain of Ganges.

People of great plains — tendency toward a nomadic life. American Indians, Arabs of the eastern deserts.
Influence upon settlement. Uplands and lowlands of New England compared.
Influence upon industry.
Seashores.
Regular — lack of harbors unfavorable to development of great nations.
Irregular — favorable to growth of nations, e.g., Greece and Rome. Great nations of to-day.
Influence of seashores upon industry.
Relation of climate to man.
Effects of extreme heat, of extreme cold upon man's mental and physical activity, e.g., dwarfs of the African forests, Eskimos of Greenland.
Effects of a temperate climate upon man. Location of the great nations of the world in heat belts.
Dry climate — importance of control directly upon vegetable life, indirectly upon animal life and man.
Industries of semi-arid plains and plateaus.
Industries of well-watered regions of gentle slopes.
Rainfall east and west of the 100th meridian W. longitude noted — effect upon industry.
Industries of regions of extreme cold — of tropical regions.
Relation of economic products to man.
Effect upon migrations. Discovery of gold in California, in Australia. Influence upon industry.
Influence of man upon the earth.
Modification of environment. Land reclaimed from the sea — dykes built, streams diverted, hills levelled, marshes drained, deserts made fertile, etc.
Distribution of plants and animals influenced.
Destruction and limitation of plant and animal life, e.g., buffaloes, seals, forests — effects of destruction of forests.
Distribution of plants and animals extended.
References.
Dodge, *A Reader in Physical Geography.*
Guyot, *The Earth and Man.*
Hayes, "The Southern Appalachians." *The National Geographic Monographs,* pp. 305–336.
Semple, "The Influence of the Appalachian Barrier upon Colonial History," *Journal of School Geography,* January, 1897.
Shaler, *Nature and Man in America.*
Tarr, *Elementary Physical Geography,* pp. 407–419.
Willis, "The Northern Appalachians." *The National Geographic Monographs,* pp. 169–202.

# Teachers College Record

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TEACHERS COLLEGE RECORD

VOL. II MAY, 1901 No. 3

# THE STUDY OF CHILDREN

BY EDWARD L. THORNDIKE

Adjunct Professor of Genetic Psychology in Teachers College, Columbia University

## Preface

The purpose of this number of the RECORD is to give an account of the work done by the department of psychology in Teachers College, and to present some of the more important data of Child Study in a form accessible to all students of children and convenient for teachers of special subjects. It will comprise brief statements of the nature and aims of the different courses offered, a more detailed account of the elementary course in Child Study, reprints of two valuable general articles now practically inaccessible to most students, and sample contributions from the literature of Child Study to the methods of teaching the separate subjects.

## WORK IN PSYCHOLOGY AT TEACHERS COLLEGE

### Introductory Course

Psychology A is a course in the scientific study of human nature and intelligence. It aims to preserve such breadth and rigor of treatment as fits a course for an academic degree and still to meet the peculiar wants of the prospective teacher. The latter end is attained by the selection of topics and by the use of illustrations from school life whenever possible. Semi-metaphys-

ical questions, such as the nature of the self, the nature of knowledge or the supra-phenomenal relation of mind and body, are entirely eliminated. Any detailed study of the physiology of the sense organs, of the relation of stimulus to sensation, or of the minute analysis of mental states into hypothetical elements, is dispensed with. Emphasis is laid upon the description of mental phenomena, an understanding of their neural basis, and especially upon the mental life in function, upon mental states in action.

Psychology A may serve as an introduction to the courses in experimental, physiological, abnormal, philosophical or genetic psychology, and to the courses in general method.

The work in all but the last two fields is carried on in the School of Philosophy, and though open to qualified students from Teachers College, need not be described here.

## GENETIC PSYCHOLOGY

Teachers College provides three courses for those who wish to study the mental development of children.

Education 9 (Child Study) presents those facts in the psychology of childhood which are of value to the teacher because they bring sympathetic insight into the conditions under which educational aims must be realized — that is, into ways and means of teaching — lend an intelligent interest to our dealings with children, and give a critical sense by which to judge the rapidly increasing literature of child study. It also affords a chance for the student to form profitable habits of observation of children. Within the limits of a two-hour course it seeks to meet the needs of the intelligent teacher.

Psychology 11 (Genetic Psychology) rehearses the facts concerning mental development in the race and in the individual, discusses the general theories which have been proposed, and describes the problems requiring solution and the methods of approaching them. It thus aims to provide the psychological data of most value to advanced students of the science of education.

Psychology 13 (Research Course in Genetic and Comparative Psychology) gives advanced students the opportunity to learn methods of original research within this field and to carry on such research with the aid of the instructor.

## Education 9 (Child Study)

The general outline of the work is as follows:

I. A general account of the physical and mental life of children. First half year.

II. (*a*) The psychology of children of the kindergarten age or (*b*) the psychology of adolescence. Three weeks of second half year.

III. The theory of mental development. Three weeks of the second half year.

IV. Children as students of the school subjects. Four weeks of the second half year.

V. The critical study of typical samples of work in child study. Six weeks of the second half year.

The work under I consists of the study of certain topics by lectures and required readings, the illustration of the facts thus acquired by systematic observation of children in and out of school and by the examination of work done by children, and practice in the use of such means of testing children's senses and mental powers, etc., as should be familiar to the well-equipped teacher.

The topics studied are: —

The problems of child study and the means of exact knowledge about them.

The physical growth of children.

General and special physical defects.

Instinctive actions.

Learning (*a*) by trial and accidental success,
(*b*) by imitation,
(*c*) by ideas.

Sensations.

The influence of previous experience.

Attention.

Memory.

Imagery.

Association of ideas.

Reasoning.

The emotions.

Involuntary acts.

Voluntary or purposive acts.

Habit.
Inhibition.
Suggestion.
Motor ability.
The moral consciousness of children.
The religious consciousness of children.
Children's interests.

The matter upon these topics is presented to the class in the form of typewritten notes (containing about 40,000 words) kept upon the reference shelf in the library. This matter is discussed in the class and supplemented by quotations from original investigations and illustrations from school life.

Ten hours are devoted by each student to the work of observation, the results being presented in a written report.

Ten hours are devoted to practice in accurate methods of making and recording physical measurements, in testing vision, hearing, and color blindness, in examining the status of more complex mental processes involving attention, discrimination, memory, etc.

II. (*a*) The topics studied are: —
Mental development in the first three years of life.
The widening and refinement of experience of physical things.
The kindergarten "occupations" in the light of children's nervous immaturity.
Kindergarten games and songs in the light of the children's lack of experience.
Symbolism in young children.

II. (*b*) The topics studied are: —
The specific mental changes due to adolescence.
The general mental changes due to adolescence.
Storm and stress.
The meaning to the teacher of the facts of adolescence.

III. The topics studied are: —
Our inherited mental equipment.
The influence of the environment
(*a*) thro the formation of habits,
(*b*) thro the acquisition of ideas,
(*c*) thro the influence of special forms of training on our general abilities.

Educational applications.

IV. The topics studied are different in different years. For 1900–1901 they are: —

The attitude of children toward the study of science.

The hygienic aspect of early instruction in reading and writing.

The fitness of abstract studies (such as formal grammar or the general laws of mathematics) for young children.

Children's likes and dislikes among studies.

V. The samples taken differ from year to year. For 1900–1901 they and the questions suggested concerning them are as follows: —

## CRITICAL STUDY OF LITERATURE ON CHILD STUDY

### THE MOTOR ABILITIES OF CHILDREN

*Pedagogical Seminary,* Vol. III, pp. 9–27.

Do children have less control over their muscles than adults?

Does this imply that we should not ask them to make fine movements?

How would you improve a child's control over his muscles?

What would hurt a child's control over his muscles?

If you decided that fine movements were dangerous in the case of very young children (4–10), what changes would you make in ways of teaching reading, writing, drawing and manual training? How many of these changes would be worth while anyway? How would you tell whether certain work was injuring the child?

Can you bring any evidence from your own experience to bear on these questions? If so, what?

Where else have we seen the influence of certain movements on the child's development?

### CHILDREN'S NOTIONS OF RIGHT AND WRONG AND OF PUNISHMENT

*Pedagogical Seminary,* Vol. III, pp. 87–96.

If we accept these accounts as roughly true, how do six-to-nine-year-old children regard punishment, as a result of wrong intentions or of certain acts? Do they think of punishment as a

corrective or as a matter of retaliation? Do they regard the letter or the spirit of laws? Why would children of this age say, "I didn't mean to"?

What general changes in their notions come with further experience? What practical precepts would you derive from this study?

Do all the children's answers represent their real feelings? Are these feelings sure signs of how they regard real punishments?

### RELIGIOUS TRAINING OF CHILDREN

N. Oppenheim. *The Development of the Child.* Chapter VI.

What is Oppenheim's chief aim in this chapter?

How does he go to work to prove his point?

Do you find any flaws in his evidence?

What dangers might one incur who should follow his advice?

*Pedagogical Seminary,* Vol. II, pp. 442–448. "Theological Life of a California Child."

Just what does this paper prove?

Just what does it assert?

### CHILDREN'S DRAWINGS

*Pedagogical Seminary,* Vol. IV, pp. 79–110.

Do children six to twelve years old copy a model when they draw?

How far do they try to represent what they see, "to hold up a mirror to nature"?

Just what do they try to do when they draw?

Are their drawings more like the work of artists, mechanical drawings or scientific drawings (e.g., the illustrations in a zoölogy book)? Why?

How would you teach drawing to children? Why?

Would you make any criticisms on the old way of drawing conventional patterns?

How may drawing work tend toward the general mental development of children?

### CHILDREN'S INTERESTS

Recall the instinctive interests of children.

Are these alike in all children? What is their importance to teachers? How are interests acquired?

Think over your own interests and how they were caused.

What different sorts of interests are, to your mind, important for the grammar school to develop? For the high school?

Read "The Interests of Children in the Reading Work of the Elementary Schools." Clark Wissler. *Pedagogical Seminary,* Vol. V, pp. 523–540.

Is it fair to suppose that the degree to which children remember stories is a measure (*a*) of the interest aroused at the time, (*b*) of the permanent effect left by the story, (*c*) of the value of the story for them?

Are the sort of selections you yourself enjoyed most at 6, 7, 8, 9, 10 years of age the ones which you think were the best for you?

Is there any reason to suppose that when you ask a boy or girl six to fourteen years old what book he or she would select, if he could pick out any one, the answer you get may not represent a real preference?

Suppose that you were teaching a fourth-grade class, how would you go about finding out just what they liked to read, just what was good for them to read?

### CHILDREN'S INTERESTS IN NATURE

Are you a successful student of science?

Do you love to study science?

Do you love animals?

Do you love plants?

Do you love rocks and rivers?

Read very critically the following references:

*Pedagogical Seminary,* Vol. III, pp. 61–86.

*Educational Review,* January, 1899, pp. 57–63.

Note any misstatements in either article.

What does the last half of *Pedagogical Seminary,* p. 76, prove about learning science?

What does *Pedagogical Seminary*, p. 77, prove?

Compare p. 75, *Pedagogical Seminary*, bottom paragraph, with p. 85, second paragraph.

Read the title of *Pedagogical Seminary* and pp. 61–86, then read p. 64, bottom paragraph, and the first half of p. 85. What have these paragraphs to do with the topic announced in the title?

What is the argument in this article?

Read with especial care *Educational Review*, p. 60 and the first half of p. 61. How far do you agree with the assertions there made? How would you find out whether they were true or not? What are various common attitudes of children toward animals, toward plants, toward the woods and country? Which among them are instinctive, unlearned? Which among them would you foster? Why?

### CHILDREN'S ATTITUDE TOWARD SCHOOL LIFE

*Pedagogical Seminary*, Vol. III, pp. 413–418.

What does this article claim to prove? What does it prove? What suggestions do you get from it? How would you go about finding out the characteristics of the best teacher? How would you go about finding out what children esteemed most in their teachers?

What questions for study would you suggest along the line of children's attitude toward school life?

### MENTAL FATIGUE IN SCHOOL CHILDREN

*Psychological Review*, Vol. VII, pp. 466–482 and 547–578.

Just what questions does this research try to answer?

What were the means taken?

What dangers is it necessary to guard against in any attempt to measure a person's ability to do mental work?

How did the author guard against them?

What different conclusions might be hastily drawn from the results?

Do you find anything of importance in the facts presented which the author does not bring out explicitly?

THE COMPARATIVE IMPORTANCE OF HEREDITY AND ENVIRONMENT

Read "History of Twins," by Francis Galton, in *Inquiries into Human Faculty,* pp. 216–243, and Chapter IV in Oppenheim's *The Development of the Child.*

Which of these articles seems to you the more scientific? Why?

Which is the more original?

What is the importance to education of such work as Galton's? How could a study of twins be made even more helpful to educational theories?

PSYCHOLOGY 11 (GENETIC PSYCHOLOGY, ADVANCED COURSE)

The work in Psychology 11 consists of lectures, required readings and individual reports. The general topics of the course are as follows: —

I. The problems of mental development and theories concerning them.

II. The development of intellect in the race.

III. The development of intellect in the individual.

IV. The development of the emotions, moral consciousness and will in the individual.

V. An analysis of human mental inheritance.

VI. Heredity and environment as factors in producing mental ability and efficiency.

VII. The influence of various forms of training on mental development.

VIII. Contributions from genetic psychology to the science of education.

IX. Special reports from members of the class.

Prescribed Readings in Psychology 11. (Subject to modification.)

I. Froebel: *Education of Man.* Chapters I and II.

Baldwin: *Mental Development in the Child and the Race.* Chapters I, VII–XVI.

James: *Principles of Psychology.* Vol. II, Chapters XXIV and XXVIII.

II. C. Lloyd Morgan: *Introduction to Comparative Psychology.* Chapters V, VII, X, XIV and XVI.
Thorndike: *Animal Intelligence.*
*The Mental Life of the Monkeys.*
III. Tracy: *Psychology of Childhood.*
Thorndike: Typewritten notes on the psychology of childhood.
IV, VII and VIII are dealt with solely by lectures.
V and VI. Galton. *Natural Inheritance.*
*Hereditary Genius.*
*Inquiries into Human Faculty,* pp. 216–243.

The subject-matter of the course is in considerable measure an original account, which goes beyond the theories in print. The readings, especially under I–IV, are for critical examination rather than actual acceptance.

## Psychology 13; Research Course

The work of Psychology 13 will be arranged to suit the needs of its members. It is intended not only for students who wish to investigate problems in animal psychology or genetic psychology, but also for such as wish to make empirical studies of the phenomena of school life which cannot conveniently be carried on in the University laboratories or in other research courses. The nature of the work may be seen from the following topics studied during 1900–1901:

The mental life of the primates and its relation to human mental development.

The mental life of typical mammals.

The growth of verbal discrimination in young children.

The influence of special forms of training sense discrimination on discriminative ability in general.

The influence of special forms of training attention and observation on the general powers of attention and observation.

The value of spelling as a formal discipline, i.e., its influence on mental functions in general.

The value of Latin as a formal discipline.

The correlations between the mental functions involved in school subjects.

An inductive study of rhetorical effects with relation to methods of teaching composition.

## The Relation of the Work in Child Study to that of Other Departments

*The relation of the work in psychology to the administration of the Horace Mann and Experimental Schools.*

It is hoped that the department may be of service to the school in two ways; first, by making any tests of the mental functions of individual children which may aid their teachers to understand and assist them, second, by making accurate determinations of the abilities or progress of classes of children in such matters as can be estimated by systematic observations.

*The relation of the work in psychology to that of other departments.*

The planning of courses and the decision concerning methods in the various school subjects depend partly upon the semi-intuitive wisdom of expert students and teachers of those subjects, and partly upon general aspects of human nature which can properly be studied by psychological methods. Questions about the hygienic aspect of studies and methods, about their effect upon mental functions in general, about their probable working in the light of general mental laws, occur from time to time and often remain unsettled because of the unavoidable ignorance on the part of the specialist with convenient and precise and rigorous methods of getting an answer. On the other hand, the studies of the unaided psychologist are likely to be trivial or irrelevant, because of his unavoidable ignorance of the problems which the specialist wishes solved. By personal intercourse with the heads of departments and concrete study of the special-methods courses it is hoped to make the department of psychology of assistance.

## CONTRIBUTIONS FROM CHILD PSYCHOLOGY TO SPECIAL METHODS

EDITED BY EDWARD L. THORNDIKE

One of the most directly useful forms of child study is the attempt to get a rational account of the way the different school subjects influence children's minds. This sort of child study has been in progress ever since there were intelligent teachers, and we find substantial agreement on many important points. Many others, however, are in dispute, and vagaries in text-books, courses of study and methods are so frequent that it does not seem out of place to put together a few of the plain facts, to discuss some of the mooted questions, and to present for critical study samples of the studies along this line which profess to be records of actual facts, not expressions of opinion.

The Editor is indebted to the *Pedagogical Seminary*, the *American Journal of Psychology* and the *Journal of Pedagogy* for permission to reprint from copyright articles. Credit is given to author and journal in the proper places.

## READING AND THE STUDY OF LITERATURE

It is easy to see that reading good literature improves the minds and morals of boys and girls, but it is hard to see just how. It is also easy to see that literary, in the sense of artistic, presentation of facts has a vastly different effect on boys and girls from that of the mere recital of the same facts or their actual experience, but nothing in human nature is harder to give an accurate account of than just what this effect is. It is easy to see that the tastes of boys and girls differ from those they will have when they grow up, and that taste differs among individual children, but it is hard to tell just what their tastes are, how they are caused and how they change.

It is self-evident that the experience of the average teacher of English literature is quite unable to secure a reliable answer to these questions. For this experience has resulted in the utmost diversity of opinion. People are teaching literature with all sorts of notions about its influence on adults, about the nature of the æsthetic emotions, especially in the young, about the tastes and interests which we find in children to start with, and about the way these change with age and culture. Because of the mental inertia which restrains all but the most strenuous souls from doing all that they think, and the general subjection to conventionality in practical procedure which characterizes most teachers, there is not such a chaos in methods of teaching literature as there is in theories about them. Yet there is enough. A list of the different books and selections read by twelve-year-olds in school to-day would amaze us all. A summary of the remarks made upon these selections by the teachers would send us from laughter to tears. Unfortunately, it cannot be said that either the cult for child study or the more systematic labor of soberer students of educational psychology has done very much better.

The literature of child study does present information about some general aspects of the mental life of young students which text-book makers and teachers have at times failed to recognize, and some definite attempts to estimate the nature of children's intellectual interests or propensities, and in particular their interests or tastes in reading. In so far as we must, willy-nilly, develop new and better interests on the basis of what we find at hand, these latter studies will, if reliable, be of considerable help in planning courses and handling material.

I shall briefly mention some of the general facts contributed by child study which seem likely to enlarge and clarify the views of teachers of English; then quote, with some comment, samples of the work on children's interests in general and reading tastes in particular; and shall, finally, discuss the matter of æsthetic appreciation from the psychological point of view.

Young children like to think and feel. They enjoy having something going on in their minds, and anything is better to them than nothing. This enjoyment of mere mental functioning may be, and has been, mistaken by teachers for æsthetic transports, scientific ardor, and religious devotion. We must remember that children may like things which we like, but for totally different

reasons, and must guard against the fallacy of the adult observer, — attributing to the child our mental attitude.

It is a general mental law that what we think or feel or do in any situation depends in great measure upon what we have thought and felt and done in the past. Children's experiences of objects and words are always factors in their appreciation of any piece of literature. What ideas and feelings do *love, envy, jealousy, ambition,* and other words describing adult passions, arouse in the ten-year-old? Certainly not those aroused in his teacher. All this teachers perhaps know, but they hardly realize the extent to which lack of experience influences not only the understanding of facts, but the appreciation of moods or literary effects. It is, in fact, a general law that works everywhere.

Children, and adults, too, are quick to assume conventional tastes, and are prone to confuse their conventional opinion that a thing is good or bad or beautiful or ugly with the real feeling of its goodness or badness. By dint of often saying that Shakspere is a great poet the student comes to think that he feels and appreciates his greatness. It is perhaps a question whether the acquisition of this pseudo-appreciation may not be a step toward the real thing. It is by no means sure that we ought always to discourage it. But it is sure that the teacher of literature should know the difference between the two and should be aware of the prevalence of this effigy of literary feeling among boys and girls, and should not be satisfied with it when real feeling can be awakened. Commonly the matter is even worse, there being not even the illusion of feeling in the scholar's mind, but only some empty phrase or so. No prophet from child study land is needed to teach us the folly of such teaching.

As a sample of the work done on the general intellectual propensities of children, I have chosen a paper by Clark Wissler, "The Interests of Children in the Reading Work of the Elementary Schools," from which I shall quote at length. The entire article may be found on pages 523–540 of Volume V of the *Pedagogical Seminary.*

# THE INTERESTS OF CHILDREN IN THE READING WORK OF THE ELEMENTARY SCHOOLS

By CLARK WISSLER, Director Psychological Laboratory,
Ohio State University

Early in October, 1895, the following list of questions was sent out to a number of school superintendents in Indiana, with a request for written answers from the pupils under their charge.

1. Write the subjects of all the lessons that you remember from the Reader you used last year.

2. Which one did you like best? What was it that you liked?

3. If you were taken to a book-store and told that you might select just one book for your own, what would you take?

4. Give your *name, age* and *grade.*

Six of these superintendents had received training in the Departments of Psychology and Pedagogy in the Indiana University, the others were known to the writer personally as men capable of carrying out such directions as were given. The questions were all presented during the same week and all of the pupils in a school wrote their answers at the same hour. The pupils were ignorant of the purpose of the questions, receiving them as an ordinary lesson in composition.

Papers were received from about 2,100 children. From the teachers' reports as to the reading work of the preceding year, irregularities appeared in four different rooms, necessitating the rejection of the papers received from the pupils of the same. There remained in all 1,950 papers, 1,060 from girls and 890 from boys. The following classification presents the gradation by Readers and by the year in the course of study, the number of boys and girls in each Reader, and their ages at the time of writing these papers.

| READER | YEAR IN COURSE OF STUDY | GIRLS | BOYS | AGES[1] |
|---|---|---|---|---|
| Second | 2 | 236 | 230 | 8 - 9 |
| Third | 3 and 4 | 300 | 243 | 9 -11 |
| Fourth | 5 and 6 | 323 | 268 | 11-13 |
| Fifth | 7 and 8 | 201 | 149 | 13-15 |

All the schools of Indiana are required to use the State Series of Readers. This study could not have been made without such uniformity in text and course of study. While all criticisms are made with reference of this Series of Readers, they apply in a general way to all books of this class, because in range of subject matter the Indiana Series is a fair representation of American reading texts.

[1] Most of the pupils fell within the range of these ages and the variations were slight and of little significance.

I

No. 1. Write the subjects of all the lessons that you remember from the Reader you used last year.

The tabulated results of the first question are presented in diagrams, showing the per cents of girls and boys remembering the consecutive lessons in each Reader. It was found impossible to make a distinction between the two grades using one Reader because pupils would remember some lessons from the part of the book belonging to the other grade.[1] The Fifth Reader is omitted in this classification because of lack of uniformity in class work.

It will be seen from the diagrams that certain lessons were remembered by a large per cent of the pupils, others by few or none. In the following will be found a brief characterization of all the lessons remembered by five per cent or less of both sexes, together with those remembered by a large per cent.

[These diagrams I have omitted, as the data are as well understood from the text itself.]

SECOND READER

A. Lessons not recalled by any one.

PART I

(Every lesson recalled)

PART II

29. "Pretty is That Pretty Does." — Alice Cary.
A short moral lesson on duplicity.

B. Lessons recalled by not to exceed 5% of both sexes.

PART I

8. "What Does Little Birdie Say?" — Tennyson.
The life of a baby compared to a bird in the nest.

9. A boy imagines his kite as high as the stars; contradicted by a passing man and given a little information as to the correct distance. Instructive.

13. "Keep Trying" — "Drive the nail aright, boys, Hit it on the head," etc.

[1] It is well known that most children read all the attractive lessons over and over before they are formally studied.

18. A little boy attempts to tell a dog story; not interesting except as a typical child's effort.

20. "Work while you work; play while you play:
This is the way to be cheerful and gay." — M. A. Stodart.

25. Short poem treating of a rainy day in life.

26. A family of boys telling what "they will be"; one resolves to comfort and love his mother.

27. Poem — six little orphan chickens nestled at night under a feather duster.

29. A lesson on brotherly kindness pointed out in a rather extravagant story of a horse and his blind mate.

30. A fable — "The Humming-Bird and the Butterfly."

PART II

4. A rule about fretting. "All children should remember this little rule, and begin to follow it while young."

7. "Words that Deceive." "A lie that looks like the truth is the worst kind of a lie."

8. "Twinkle, twinkle, little star."

12. "Speak Gently." A well-known poem.

13. A brief account of swallows building a nest over a little boy's window.

16. An eagle flies away with a rattlesnake and is killed by it.

17. "The Drink For You." A temperance poem.

18. A brief natural history of the harvest-mouse.

19. Prose rendering of the "Leak in the Dike."

21. "Great, wide, beautiful, wonderful World." A poetical picture of the world from Lilliput Lectures.

22. Story of a girl who was so kind to the birds that they came to her for food.

28. "The Spider." Similar to No. 18 with a lesson on perseverance.

C. Lessons recalled by a great number of children.

PART I

1. A life-like sketch of some boys playing at top.

2. Story of a little girl's lamb that remembered her after a long absence.

21, 22, 23. A simple rendering of the story of King Midas, or the Golden Touch.

PART II

5, 6. A story of a little girl's visit to the inhabitants of the Arctics.

## THIRD READER

A. Lessons not recalled by any one.

### Part I

8, 50, 55, 56, 57. Topical reviews, picture lessons, etc.
19. Story of a rain-drop. Instructive.

### Part II

7, 43, 52, 56, 62, 63. Topical reviews, etc.
6. "Song of Summer." — Mary Mapes Dodge. Short.
16. "Golden-Rod." Poetical lesson on contentment.
21. Collection of old proverbs.
24. Kind acts rewarded.
30. Similar to No. 16. Dicontented Buttercup.
32. Moral precepts in verse form.
46. Moral lesson on dreaming and doing.
49. "A Seed." Two little verses.
50. Life of a little girl saved by a bird. (An interesting story to the writer of this paper.)

B. Lessons recalled by not to exceed 5% of both sexes.

### Part I

17. A short prayer in verse.
21. Moral lesson — smile and the world smiles too.
22. "Can you?" — Mary E. Folsom. Designed as an elocutionary lesson.
23. Short lesson on true courage.
27. A short allegory on human life.
31. Lesson on conduct. Verse.
32. About ants. Instructive.
33. Two pages from "Aladdin's Lamp."
34. A bird's lament for her nest. Verse.
35. Duty to the aged. Verse.
37. "The Little Brown Thrush." — Lucy Larcom.
39. Some games. Instructive.
40. "Why People Eat." — Instructive.
41. "Suppose." — Phœbe Cary.
42. Moral lesson — Look to your own faults first.
43. Stories of parrots.
45. Moral lesson on delay.
46. The Dog in the Manger. A fable.

48. Moral lesson on doing and giving.
49. The world's coöperation in making a pudding. Instructive.
52. "Spring is Coming." — Mary Howitt.
52. "The Dog and the Shadow."
53. A short bright story of two little pigs.
54. "May's Good-Night." — Mary H. Burnett.

PART II

3. Short account of how a dime is made. Instructive.
4. Play of children as seen by adults.
5. Short account of silk production. Instructive.
10. "Speak the Truth."
14. Verses on the Beautiful in Character.
15. What Live on Flowers? Instructive.
20. "Father is Coming." — Mary Howitt.
23. The Wolf in Sheep's Clothing. A fable.
25. "What God Hath Made." — W. B. O. Peabody.
26. A comparative study of teeth. Instructive.
31. About fruit. Instructive.
33. A study of the hand. Instructive.
35. A comparative study of the hand. Instructive.
42. "The Wind and the Leaves." Allegorical.
44. "Sleigh-Bells." A jingling poem.
45, 47. About metals. Instructive.
48. Anecdote of a dog.
51. Two verses about a happy girl.
53. About birds' nests. Instructive.
54. A poem — All things come from God.
58. Longfellow's Beautiful Rain in prose form to be put into verse.
61. "The Hour of Prayer." — Mrs. Hemans.

C. Lessons recalled by a great number of children.

PART I

1. A dog that cared for his blind master.
2. Hans Andersen's Five Peas in a Pod.
10, 11. Nellie Grant as the ideal little girl.
24, 25, 26. Paul Dombey. Adapted from Dickens.

PART II

1. Biographical sketch of Washington.
11. Story of a dog saving a child from drowning.
17. A dog saving a boy lost in the snow.
40. "Piccola." — Celia Laighton Thaxter.

## FOURTH READER

A. Lessons not recalled by any one.

### Part I

14, 20, 34, 37, 39, 43, 49, 56, 57. Topical Reviews, etc.
4. About the hand. Instructive.
10. Fables — Farmer and the Stork, The Crow and the Pitcher.
21. "The Voice of Spring." — Mrs. Hemans.
22. "The Grave." — James Montgomery.
31. A few lines from Byron. Heroic.
38. Fable — The Wind and the Snow.
45. "Birds in Summer." — Mary Howitt.
46. A stanza of four lines. Moral.
51. Classification of the teeth. Instructive.
53. "Kitty." — Miriam Douglas.
54. Riddles and humorous plays upon words.
55. Use of metals. Very short and instructive.

### Part II

44, 51, 52. Topical Reviews, etc.
4. Short abstract discussion of silent reading.
19. The Romans. Short extract from E. A. Freeman
20. Short account of the Sahara. Difficult.
31. Allegorical story of a leaf. Human life.
34. "The Creation." — Addison.
36. A story with a moral.
38. Some of Poor Richard's Sayings.
39. A one-page story of heroism, from Carlyle.
41. A part of the 106th Psalm.
45. A study in words from Webster's Spelling Book.
47. Extracts from the Bible.
48. The Christmas Dance, from Dickens's Christmas Carol.

B. Lessons recalled by not to exceed 5% of both sexes.

### Part I

11. A few lines from "How Sleep the Brave."
24. A few simple rules of health.
25. A model composition with suggestions.
42. "Wanted — A Boy." A moral lesson.

PART II

10. About the atmosphere. Difficult and instructive.
17. Monkeys making a bridge. Instructive.
21. "Babie Bell." — T. B. Aldrich.
27. Biographical sketch of Adams and Jefferson.
32. "Young Lochinvar." — Scott.
35. Biographical sketch of Andrew Jackson.
40. "Burial of Sir John Moore." — Wolfe.

C. Lessons recalled by a great number of children.

PART I

1. Sketch of Franklin, with his own story of the whistle.
2. A man telling a king the story of the locusts. An odd story.
7. Preparing for Christmas. A selection from "Little Women."
9. "Ellen More." — Mary Howitt.
13. "The Old Oaken Bucket."
15, 16, 17, 18. The Ugly Duckling, from Hans Andersen.
26, 27. The Life and Anecdotes of Columbus.
28. "The Day is Done." — Longfellow.
29, 30. Story of a dog that wandered off into the world and after a long time saved the life of a child.

PART II

1. Sketch of Daniel Webster.
11. "The Gemsé Fawn." Pretty story in verse.
12. Mr. Squeers and the Boarding School. — Dickens.
14, 15, 16. The Battle of Bunker Hill.
18. "Flowers the Stars of Earth." — Longfellow.
22. "We are Seven." — Wordsworth.
25. Marshal Macdonald rescuing a little drummer boy carried down by an Alpine avalanche.
28. "Lucy Gray." — Wordsworth.
43. "The Little Match Girl." — Hans Andersen.
50. An Arabian horse saves his wounded master by taking the man's belt in his teeth and bearing him home.

SUMMARY

| | Second Reader | Third Reader | Fourth Reader |
|---|---|---|---|
| Per cent of total number of lessons not recalled | 1 | 17 | 33 |
| Per cent of lessons recalled by not to exceed 5 per cent. | 34 | 40 | 11 |
| Per cent of lessons recalled by a great number of children | 10 | 9 | 23 |
| Per cent of lessons recalled by an intermediate number | 55 | 34 | 33 |

This characterization of lessons has been presented that the reader might see for himself the number and the nature of the lessons falling under the principal divisions. Space does not permit the discussion of details or a presentation of a characterization of all the lessons of the various Readers. The foregoing gives a rough gradation of lessons from the impressive to the indifferent. Bearing in mind that this study is based upon the returns of about 500 children to each Reader, it is a very severe criticism to say that no one remembered certain lessons. From this point of view, about 16% of the aggregate number of lessons in the three Readers represents time wasted. Little more can be said for the 28% named by not to exceed 5% of the pupils. That is to say that 44% of the number of lessons in the Indiana Series could have been omitted without loss to the pupils.

An examination of the diagrams and the foregoing classification leads to the following conclusions:

The first lesson of the different Readers is well remembered, also the continued lesson, or long story.

All of the lessons remembered to any great extent, except a few remembered for their oddities, are in terms of experience the child can realize in himself.

The lessons remembered most are especially natural, or life-like.

The curves of the sexes are remarkable in agreement, that of one appearing a duplicate of the other. The principal difference is in the number of lessons remembered, girls remembering more than boys.

The lessons not remembered by any child are too short to excite interest or do not treat of things a child can appreciate.

The mere instructive lesson; the moral and its setting; abstract poems concerning duty, happiness, love of nature, etc., make up the bulk of those remembered by 5%, or less.

## II

No. 2. Which one did you like best? What was it that you liked?

The range of preference was great. In very few cases did more than 10% of the pupils prefer a given lesson. The extreme was for the first lesson of the Second Reader, which was preferred by 21%.

It seemed difficult for many pupils to decide which of the lessons they preferred; e.g., many said they "liked them all (all they remembered), but thought they liked best, etc." But when it came to saying what it was they liked about a lesson no hesitation was apparent. Because of the lack of decision in the former, the writer is inclined to believe that the number remembering a lesson is a better indication of what impressed the children than the number preferring the same.

The following general classification (Table I) of the lessons into poetical and prose, together with the preferences for the same, shows the total number of choices falling upon poetical selections to be large, notwithstanding that the number of prose selections in the Readers is more

than twice that of poetry. A remarkable increase in the preference for poetry appears in the Fifth Grade where such poems as Evangeline, Thanatopsis, Snow-Bound, etc., were read. In every case the girls lead in the preference for poetry.

TABLE I

*Distribution of preferences as to Poetry and Prose*

| | Number of Selections | Per Cent. of Children Preferring | |
|---|---|---|---|
| | | Girls | Boys |
| **Second Reader** | | | |
| Poetry | 18 | 14 | 8 |
| Prose | 47 | 86 | 92 |
| **Third Reader** | | | |
| Poetry | 40 | 22 | 15 |
| Prose | 80 | 78 | 85 |
| **Fourth Reader** | | | |
| Poetry | 31 | 33 | 27 |
| Prose | 78 | 67 | 73 |
| **Fifth Reader** | | | |
| Poetry | Work | 81 | 66 |
| Prose | Irregular | 19 | 34 |
| **Total** | | | |
| Poetry | | 37 | 29 |
| Prose | | 63 | 71 |

Some facts of general significance appear in the table. There is a growth of interest in the poetical coincident with age, beginning with a low per cent and ending with a high per cent. It is probable that young children are interested only in the rhythm of verse as found in rhymes of the Mother Goose type, and that real poetry receives little recognition before the adolescent period. The general preference for poetry in the Grammar Grades (Fifth Reader) is, at least, a vindication of the right of such poems as Evangeline and Thanatopsis to a place in the Seventh and Eighth Years of the Course of Study. The poems in the Second and Third Readers are chiefly those of sentiment and thought, but the preferences fall upon those in which rhythm is prominent; as

"Two little kittens, one stormy night,
Began to quarrel, and then to fight." Popular, in the Second Reader.

"Now, such a story I never heard!
There was a little shivering bird!" Popular, in the Third Reader.

In the Fourth Reader a transition is shown in preference for "We are Seven," and "Old Oaken Bucket," with scattering preferences for

more weighty verses. Then in the Fifth Reader are many preferences for "Rainy Day," "Thanatopsis," "Evangeline," etc. In general, the interest in verse begins in childhood with the rhythm and passes over gradually into sentiment and thought in adolescence. The makers of our textbooks have not taken this into account.

Since the subject matter of a selection does not depend upon the form, a close view of the children's interests necessitates a classification of the lessons with regard to general theme. Table II presents the relative preferences for selections classed under the given themes.

TABLE II

*Classification of lessons according to theme, showing preferences for each class*

| | 2nd R. | | 3rd R. | | 4th R. | | 5th R. | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | G. % | B. % | G. % | B. % | G. % | B. % | G. % | B. % | G. % | B. % |
| Fables | 1 | 1 | 3 | 5 | 0 | 1 | 0 | 0 | 1 | 2 |
| Heroism | 4 | 3 | 0 | 0 | 10 | 24 | 4 | 7 | 5 | 8 |
| Biography | 0 | 0 | 12 | 11 | 7 | 6 | 2 | 4 | 5 | 5 |
| Stories of animals | 19 | 21 | 12 | 14 | 14 | 11 | 0 | 0 | 12 | 12 |
| Adventure | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 |
| Information | 2 | 1 | 2 | 4 | 2 | 2 | 3 | 1 | 2 | 2 |
| Moral Precepts | 4 | 3 | 9 | 8 | 0 | 2 | 17 | 18 | 7 | 8 |
| Stories of Daily Life | 39 | 41 | 28 | 24 | 32 | 20 | 35 | 35 | 34 | 30 |
| Description | 4 | 3 | 4 | 0 | 3 | 3 | 33 | 30 | 11 | 9 |
| Unclassified[1] | 27 | 27 | 30 | 34 | 32 | 29 | 6 | 4 | 23 | 23 |

[These figures may be misleading, for we are not told how many of each sort of stories the readers in question contained. For instance, if in the second reader 50% of the stories were of the "*moral precept*" order and only 5% of the "*daily life*" order, the fact that only 4 and 3% of the former were preferred to 39 and 41% of the latter would be all the more impressive, while if there were only 5% of "moral precept" stories in the reader and 50% of "daily life" stories, the percentages of preferences would have much less weight. For children will be more likely to find a story to prefer in ten of a certain sort than in one, and in so far as their

[1] A large number of pupils preferred selections from other books, and as we had no means of knowing where to look for these preferences, they were placed with the few lessons of the Readers that failed to fall under the other heads. The schools from which these papers were received have in the school libraries several sets of Readers used as supplementary texts.

stated preferences were due to chance they would be proportional to the percentages of the different kinds of stories in the readers.

For this reason also the estimates of the change in interests through the grades may be misleading, for if the later readers did not have the same proportion of the different types of selections as the earlier the dice would be weighted and the changes observed might be in part due to the different material offered for interest to choose from.]

In this connection some idea of the reasons given for these preferences is necessary. (See No. 2 of the syllabus.) After reading a large number of answers to this part of the question, the following empirical classification was determined upon.

Reasons for preferring:

1. No reason given.
2. "Interesting"—only such as employed this word, and it may mean different things in different cases.
3. "Beautiful," "nice," "pretty."
4. All answers indicating the desire for knowledge [as] the ruling factor in the choice.
5. All basing the preference upon the acquisition of a moral principle.
6. All in which the child found pleasure in his experiences reproduced in the lesson; i.e., true to life.
7. All indicating the child's pleasure in heroic action.
8. Miscellaneous and oddities.

For results see Table III.

TABLE III

*Classified as to the basis of the preference*

| | 2nd R. | | 3rd R. | | 4th R. | | 5th R. | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | G. | B. | G. | B. | G. | B. | G. | B. | G. | B. |
| | % | % | % | % | % | % | % | % | % | % |
| 1. None | 20 | 17 | 8 | 9 | 6 | 6 | 5 | 12 | 10 | 11 |
| 2. "Interesting" | 0 | 1 | 2 | 2 | 3 | 4 | 4 | 10 | 2 | 3 |
| 3. Beautiful | 7 | 7 | 5 | 3 | 2 | 4 | 3 | 0 | 4 | 4 |
| 4. Information | 7 | 9 | 9 | 11 | 6 | 10 | 9 | 10 | 8 | 10 |
| 5. Moral lessons | 13 | 13 | 17 | 14 | 42 | 30 | 26 | 25 | 26 | 20 |
| 6. True to life | 39 | 33 | 27 | 25 | 21 | 18 | 22 | 18 | 27 | 24 |
| 7. Heroic | 4 | 7 | 17 | 20 | 11 | 24 | 5 | 12 | 10 | 16 |
| 8. Unclassified | 10 | 13 | 15 | 16 | 9 | 4 | 26 | 13 | 13 | 12 |

From this we find that the children preferred most lessons that suggested a moral truth, a bit of real life or heroic action. The boys lead in

the latter. A gradual decline of interest in the life-like is observed with a corresponding gain in the moral and the heroic. In the Second Reader nearly 40% were attracted by the life-like, while in the Fifth about 20%. It is probable that young children are content with the images called up by a selection, while older heads look for hidden significance and abstract principle. To the child it is enough that he loves a thing "because it did" a certain way, but the youth scorns such a makeshift, basing his admiration upon the presence of practical suggestion or laudable personal characteristic. Yet even in the case of the youth, are we sure that he has not employed his reason for the concealment of his original simplicity?

No marked sex difference appears either in preference or in basis of preference, and the uniformity of per cents in Tables II and III shows that in this respect girls and boys stand upon equal footing. The nicety of balance between the per cents for the sexes gives peculiar force to this result.

Table III is indicative of the interests of the children. Its results differ from the classification by themes because the different phases of the lesson appeal to different individuals. In general, it represents what the child saw in the lesson. Table II gives about 32% of the preferences to Stories of Life, 12% to Stories of Animals, 7½% to Moral Precepts, 1% to Fables, 6% to Heroism, and 2% to the instructive. Table III gives reasons for preference about 25% as life-like, 23% as Moral Lessons, 13% as Heroic, and 9% as instructive. From this it appears that the fable received little consideration, and that even the moral lesson without the formal statement in conclusion, but bearing upon it the marks of a moral purpose, received less attention than the simple story whose moral force was felt and appreciated. It is further observed that the heroic in action is given more consideration than the formal hero, and that lessons designed to be instructive receive little regard from those whose preferences lean toward knowledge. The charge is often made that children have no regard for moral ideas, no feeling for the divinity of right action, and no love for knowledge; these results show that children do appreciate such things when presented in terms of their own experience. Take out of their text-books the sermon, the philosophical fable and the cold stiff hero, and paint into them the good, the true and the heroic in colors from life.

## III

No. 3. If you were taken to a book-store and told that you might select just one book for your own, what would you take?

The choice of the children fell upon 246 different books. Twelve of the leading books are given here with the per cents of the girls and boys choosing the same.[1]

[1] For a similar list see Report on Child Reading, by H. C. Henderson. Report of the Department [of] Public Instruction of the State of New York, 1897.

| TITLE | GIRLS | BOYS |
|---|---|---|
| Longfellow's Poems | 11% | 8% |
| Robinson Crusoe | 7 | 12 |
| "A History" | 5 | 9 |
| Bible | 5 | 4 |
| Seven Little Sisters | 4 | 3 |
| "A Story Book" | 3 | 5 |
| Black Beauty | 2 | 3 |
| Uncle Tom's Cabin | 2 | 2 |
| Little Lord Fauntleroy | 3 | 1 |
| Man of the House | 2 | 2 |
| Little Women | 2 | 0 |
| George Washington | 2 | 3 |

None of these books can be said to be popular, unless it be Longfellow. While of the total number of pupils only about 10% chose this book, the number of girls in the Fourth and Fifth Readers choosing the same is about 14% and 25% respectively. Deducting the number of pupils in the Second Reader, since they had little opportunity of becoming acquainted with Longfellow's writing, we find that 14% of the girls and 10% of the boys chose a volume of his poems.[1]

In Table IV is shown the distribution of choices among the different classes of books chosen, according to text-book gradation.

TABLE IV

| | Reader | II | III | IV | V | Totals | |
|---|---|---|---|---|---|---|---|
| 1. Fiction | Girls | 66% | 66% | 42% | 36% | 53% | 53% |
| | Boys | 74 | 54 | 43 | 32 | 53 | |
| 2. Poetry | Girls | 2 | 10 | 24 | 44 | 18 | 14.5 |
| | Boys | 1 | 9 | 13 | 27 | 11 | |
| 3. Biography | Girls | 3 | 5 | 5 | 6 | 5 | 5.5 |
| | Boys | 2 | 6 | 9 | 11 | 6 | |
| 4. Travel | Girls | 0 | 0 | 0 | 0 | 0 | 0.5 |
| | Boys | 0 | 0 | 1 | 5 | 1 | |
| 5. History | Girls | 0 | 4 | 10 | 5 | 5 | 7.5 |
| | Boys | 1 | 9 | 19 | 10 | 10 | |
| 6. Religion | Girls | 8 | 6 | 8 | 1 | 6 | 5.0 |
| | Boys | 5 | 4 | 4 | 4 | 4 | |
| 7. Science | Girls | 1 | 2 | 0 | 1 | 0 | 2.0 |
| | Boys | 2 | 4 | 3 | 2 | 3 | |
| 8. Humor | Girls | 0 | 0 | 0 | 1 | 0 | 0.5 |
| | Boys | 1 | 1 | 0 | 2 | 1 | |
| 9. Miscellaneous and Unintelligible | Girls | 20 | 6 | 11 | 6 | 10 | 10.0 |
| | Boys | 14 | 14 | 8 | 7 | 10 | |

[1] In a Study in Moral Education, by J. R. Street, *Pedagogical Seminary*, July, 1897, p. 28, Longfellow is shown to be the most popular author among young people.

From this it appears that 53% of the children chose fiction, 15% poetry, 7% historical books, 6% biography and 5% religious books. This indicates a great interest in the story and the novel. The poetical works chosen were the poems of Longfellow, Bryant, Riley, Lowell, Whittier, Holmes, and the Cary sisters.

Sex differences are found here. The boys possessed greater individuality of choice. Though the number of boys (890) was less than that of girls (1060), the choices of the former fell upon 175 different books, the latter upon 157. The range of choice is represented by the average number of pupils choosing each book. The averages for girls were: Second Reader — 4.2+, Third Reader — 4.8+, Fourth Reader — 3.7+, and Fifth Reader — 4.2+: for boys 4.8+, 2.9+, 2.5+, and 2.6+. In both the maximum range was reached in the Fourth Reader.

[The sex differences and the changes due to age which Table IV manifests are summed up by Mr. Wissler as follows:]

1. *Fiction.* That there is little difference in the sexes; both showing a gradual decline with the advancement of age.

2. *Poetry.* That the interest of both sexes increases rapidly with age, but that the girls lead with a constant gain.

3. *Biography.* That the boys lead.

4. *Travel.* That books of this kind did not interest either sex.

5. *History.* That the boys lead, but the girls follow in parallel; the maximum is reached in the Fourth Reader.

6. *Religious Books.* That the interest is approximately constant.

7. *Science.* That the general interest is small, the boys leading.

8. *Humor.* That the interest is very small. Humor is the product of the mature, and the highest types are found among the most mentally acute. The appreciation of it begins about the time of adolescence.

The curves show that the child comes to the Second Reader with a great interest in the story, while interests in other kinds of writing have barely taken form. The broadening influence of the school makes him conscious of other things, especially of poetry, where he finds things that cease to be fiction when he feels them true of himself. In the Fifth Reader poetry and fiction become rivals, the former favored by girls, the latter by boys; this results in a decline of interest in other literature.

The curves of the sexes for biography, history and poetry have the same general direction and suggest a greater susceptibility of girls to school influences. The school turns its forces upon boy and girl alike, but meets greater resistance in one or the other. At the start the sexes have much in common, but growth brings divergence.

A general sex difference appears from an examination of the books peculiar to the choice of each. Both lists contain a large and approximately equal per cent of fiction, but this fiction differs in kind. Among the works of fiction chosen by girls are many books that portray the home life and every-day thought and emotion. The love story interests the older girls. Many boys preferred fiction reciting the exploits of the

adventurer in the garb of the scout, the explorer, the soldier, or the "young man making his way in the world." The books not belonging to the class of fiction are of a practical nature, but show the same differences; the girls choosing more of those relating to deportment and social and domestic training, while the boys led in those relating to industrial or professional lines. In general it seems that the girls have greater interests in the field of action where affection and kindness are striving for the noble and the true, the boys in that field of action where strength, courage and honesty of purpose struggle against the more material environment.

[In a somewhat similar study Miss Clara Vostrovsky discusses the sex differences in taste, on the basis of the statements of school children as to the last book they took from the library, and why they liked it, in case they did. She says:]

Not only do more girls than boys rely on a mere feeling of niceness in regard to their reading, but more, too, rely on the recommendations of their friends. The greater independence on the boys' part goes with the more definite reasons for taking out books, which is confirmed by the greater percentage under "substance and school." The inference that boys are guided more by reason, girls more by sentiment, in their reading, is strengthened by the fact that the results in Juvenile, Fiction, and General Literature corroborate one another in regard to this.

* * * * * * * *

Certain other very marked differences between the sexes come out in this study, particularly in a classification of the children's tastes as definitely mentioned by themselves, especially in regard to the juvenile story books which they read, since it was found that in drawing these the children consulted their real interests most often. In this classification 52% of the girls say that they took the story because it was about children (generally about girls), while this is true of only 12% of the boys. Only 24% of the girls chose the book because it was exciting, while 76% of the boys state their delight in the venturesome. This great difference is made still greater by the fact that the exciting stories mentioned by the girls are very quiet compared to those mentioned by the boys, "The Young Lieutenant," by Adams, and "Robinson Crusoe" being perhaps the most exciting. The boys' tastes in general are well illustrated by a boy of twelve, who states that he took "The Moose Hunters" because he liked to read "about the wilderness of the world";[1] while the following sentiment by a girl of fourteen is shared by a large number of others, "I like 'Quinnebasset Girls,'" she says, "because it tells all about the thoughts and feelings of girls."

[1] It is probably due to a recognition of this that certain boys' magazines, like Harper's "Round Table," which devote themselves largely to stories of adventure, have achieved so great a popularity.

TABLE I

*Showing Children's Tastes, as Definitely Mentioned by Themselves*

| | Boys Per Cent | Girls Per Cent |
|---|---|---|
| Because of children . . . | 12 | 52 |
| Because of adventures, etc. . | 76 | 24 |
| Because funny . . . . . | 6 | 12 |
| Because of miscellaneous reasons | 6 | 12 |

Since the name of a book presumably plays some part, however unconsciously, in deciding whether or not it will prove interesting, the juvenile books were again classified to see whether the titles in themselves bore out, in the main, the children's statements in regard to their preferences. 71% of the girls' books had names suggestive of children, while this was true only of 21% of the boys' books. While some of those mentioned by the girls were in regard to boys alone, not one given by the boys was merely in regard to girls. Are girls, then, more interested in their brothers than boys are interested in their sisters? Only 10% of the names of the girls' books indicated adventures, against 50 per cent of the boys. which had such suggestive titles as "The Young Defenders," "A Night in the Swamp," etc.

TABLE J

*In Regard to Titles of Last Book*

| | Boys Per Cent | Girls Per Cent |
|---|---|---|
| Of children . . . . . | 21 | 71 |
| Of adventures, etc. . . . | 50 | 10 |
| Of fairy-land . . . . . | 6 | 6 |
| Miscellaneous . . . . . | 23 | 13 |

All this taken together, seems to indicate [in] girls more domestic and [in] boys more adventuresome tastes. It is in line with what Max. Pemberton, who has himself written books for boys and edited a boys' paper, has to say: "For style a boy cares nothing; he reads Stevenson for the story. He must have incident, excitement, — a hero."

When we come to the authors most often mentioned by boys and girls, we meet again the wide dissimilarity in their preferences. Girls mention 79 different authors, boys 65. Only 17 are mentioned by both, and of these, Louisa Alcott and Horatio Alger are apparently the only ones who enjoy at all anything like equal favor.

Alcott, by far, stands first in the girls' list; Sophie May comes next, followed by Martha Finley, H. Alger, Minnie Paull, Frances H. Burnett, in the order given, — almost all women writers, it will be seen.

W. T. Adams (Oliver Optic) is the favorite with boys, being named

almost twice as often as his successor, Henty. Then come Edward S. Ellis, Horatio Alger, followed by Harry Castleman, J. T. Trowbridge, and L. A. Alcott, — in this case almost all men writers.

In fiction, taking the entire number of books mentioned, it is interesting to find that more standard works were drawn by boys than by girls. — *Pedagogical Seminary*, Vol. VI, pp. 532-534.

## THE ÆSTHETIC EMOTIONS

If we are to know what we are about when we are teaching English literature to boys and girls, we must get some rational account of what the æsthetic emotions are and what they do to us. Knowledge abdicates and opinion reigns if we ask just what the so-called æsthetic effects are and what difference they make in one's general character. This is a psychological question, to be settled by psychological methods, and it is a shame that, at least since Aristotle, the best work and the bulk of the work should have been done by literary men who had the data but not the means of handling them or of understanding their significance. The equipment fit to solve the question is that of a gifted person, acquainted with psychology, and possessed of psychological insight, who has studied extensively the effects of literature on people, particularly on children, for the nature and functions of the æsthetic emotions will be clear only in the light of their origin and development. No such person has appeared with the answer, and we must be content with clearing a passage for him in so far as present data allow.

This is no occasion for a treatise on the æsthetic emotions from the standpoint of genetic psychology, and no such treatise will be attempted. Let us simply try to see clearly what facts we can state as a supplement to the existing material on æsthetics and literary criticism, which may assist the intelligent teacher to an insight into what happens when students are led to read literature ostensibly for æsthetic enjoyment, for fun.

First of all, with any given piece of literature, all sorts of different things happen in different people. Not only do many of them fail to get the æsthetic pleasure intended, but in those who do it takes many forms. Of those who do not, some feel in its place *bona fide* feelings, actual attitudes toward the real world, real, not æsthetic, emotions. These may be to them de-

sirable or the reverse. Of those who do, some feel an enjoyment of the technical skill with which the writer has secured his effect; they enjoy the poem as the foot-ball expert enjoys watching a game, not caring which side advances, unmoved by the zeal of combat, influenced only by the skill of the plays, the adroitness of the generalship, the technical beauty of the way things are done. Some feel the sensory delights of rhythm or melody; they enjoy the poem as the artist might enjoy the proportions of the foot-ball player, the grace and ease of his movements (rare enough in a foot-ball player). The majority enjoy what is poorly called, for lack of a better word, the *suggestiveness* of the poem, the mood it arouses, the feelings of joy or sadness or pity or faith, that are not real joy or sadness, but, somehow, are sweet. "It means so much, it made me feel the thing," they say. These are like the spectators who enjoy a foot-ball game because men may, and do, get hurt, because they feel, yet without results to their own profit or loss, the ambition for victory, the pluck and catastrophe and recovery. There are, of course, all sorts of combinations of these three types.

It is obvious that what we would at the first blush call "æsthetic appreciation" turns out to be now one thing, now another, now a complex. Indeed, many people, failing to experience any of these three mental conditions, take definite ideas or ordinary emotional feelings to be the "æsthetic emotions" of which they read. Many a one there is who reads his Browning in dead earnest as a sort of philosophy, commentary on human nature and moral guide, happy to get great ideas and feel new hatred of this and love of that, and thinks that he gets all there is in the poetry for any one, and wonders how intelligent people can endure Keats. From this ambiguity of the words "æsthetic appreciation" and "æsthetic emotions" has arisen much confusion. Let us therefore use the terms ideas, real emotions, enjoyment of workmanship, sensory pleasures, and pseudo-emotions to cover the main facts of the mental conditions aroused by literature. Of these terms, we may further define real and pseudo-emotions. Let us mean by real emotions such feelings as lead us to acts appropriate to the situation if real. The countryman at the theatre who wants to climb on the stage and knock down the villain in the play offers an example. Let us mean by pseudo-emotions such feelings as do not. If we enjoy reading or

seeing the last act of "Othello," it is because our emotions are not such as lead us to shriek with horror or turn away our eyes from the awful sight. We may now secure some profit from the analysis and natural history of these various effects.

The ordinary laws of human nature account for the nature of the ideas aroused by works of art, and we have seen that in practice the service of literature in presenting ideas and arousing ideals has been recognized.

The production of real emotions is of two sorts. The poem or story may arouse the emotion which the facts or events portrayed would, if real, or it may arouse some different emotion. The example already given is of the first sort. The arousal of a high flood of joyous excitement by the description of a double duel in the dark is of the second sort. The practical problem of when and where it is desirable to use literature to induce real emotions is not hard. We may merely repeat Professor James's warning against exciting them without providing some useful outlet in conduct and insisting that it be taken then or later. We may also suggest that the rational man will regulate his emotional attitude toward the real world by the facts of that world itself rather than by second-hand and often distorted pictures of them, and that there is some danger in forever wheedling people into being wise or good or happy. However, as things go, most of us will probably have to be wheedled.

The enjoyment of workmanship is so rare among young students that nothing need here be said of it.

The sensory pleasures are a far less important part of appreciation in the case of literature than in the case of music, painting or sculpture. Either because we are born with organizations which like certain combinations of sounds, lengths, stresses and pauses, or because these combinations have gone with other desirable things, we come to like certain rhythms, etc. The explanation of those due to our organization will undoubtedly turn out a purely physiological one. The explanation of the second sort is a matter of association.

The sensory pleasures appear early in the child's love of rhythm, and are moulded by precepts to some extent, still more by example. The æsthetic education of children in the purely sensory appreciation of literature can thus begin early.

What, now, of the chief problem in the æsthetics of litera-

ture, the nature of these pseudo-emotions? What is the æsthetic pity that is not real pity, the sympathy with the hero which does not produce real pain or real tendencies to help him? They are not the real emotions in weaker intensity. On the contrary, they may be stronger. They are qualitatively different. This difference is not, as has been suggested by some writers, the absence of a personal element; we do not feel real emotions with a personal warmth and intimacy and æsthetic, or, to use our word, pseudo-emotions, with the calm of an indifferent spectator.

The qualitative differences that one finds by observing himself and questioning other people are that the painful quality of many real emotions is absent from their pseudo-equivalents,— we like to feel pseudo-sorrow. The pseudo-emotions are less permanent and, therefore, more easily modifiable. The tendency to fatigue and prostration, which is a result of real emotions, is largely absent in the case of the pseudo-emotions. A man tired from the excitement of a fit of rage might go to see "Othello" to get rested.

If we now become genetic psychologists for a moment, we may find the key to the real nature and function of these emotions. For they evidently grow out of the imaginative play of children. Children systematically and habitually turn the objects and events of the natural world into means for keeping their mental life going. They themselves play the rôles and make their own actions help to arouse the feelings they so enjoy. They learn readily, and in easily ascertainable ways, to so manipulate their environment as to get such feelings out of it as do not bring painful consequences or the need of hateful inhibition and effort. A witness to the connection between the later pseudo-emotions due to literature and the earlier pseudo-emotions due to play is found in the frequent tendency of young readers to put themselves in the place of some one of the personages in a story. The boy makes the hero's words his words, the hero's acts his acts, and lets the rest of the book be a stage for his adventures, and thus assimilates the new form of mental play to the old form in which he himself did actually run and fight and conquer. Were I to rename the process of enjoying literature, I should call it "contemplative play." Were I asked to tell the date of appearance of the æsthetic or pseudo-emotions, I should answer that when the baby begins to act for the sake of gaining feelings

other than those connected with such purely physical matters as food, warmth, exercise and protection, then and there he starts on the æsthetic highway. When he begins to use words as a means of gaining such feelings, his career as an appreciator of literature has begun, and from then on a continuous development may be traced.

Children like to feel, we said in another connection, just as they like to move. To have things going on in their minds is *per se* desirable. The desirability increases in proportion as they can exclude the particular elements of feeling which cause discomfort. Chief of these are certain sensations and emotions which nature provides as warning signs against dangerous conditions and the feeling of effort or inhibition which is present when we keep some thought or feeling down. In their play, I said a moment ago, children so manipulate their environment as to get such feelings out of it as do not bring painful consequences or the need of hateful inhibition and effort. The feelings brought by play then differ from those of serious life by virtue of what they are not, by virtue of the pain and effort that they do not arouse. Here we have our fundamental distinction between the pseudo and the real emotions. The former differ from the latter by virtue of what they are not, by being responses to stimuli which the wisdom of long literary effort has devised to arouse feelings minus certain undesirable elements. Just as the child finds the acts and ideas that excite without frightening or stimulate without effort, so the tribe of writers have found means of presentation which filter off the joy of conflict from its tremors, the sweet of sympathy from the bitter, the thrills of ambition from its strife and worry, the zest of interest from its strain and effort.

From the nature and genesis of these pseudo-emotions we may now hope to learn their function. Except by special dispensation, they do not serve to purify the mind of their real parallels. There is no reason why they should, and no evidence that they do. Nor do they serve to predispose the mind to their real parallels. It does not make children feel real lonesomeness to read *Robinson Crusoe,* nor real bloodthirstiness to read *The Last of the Mohicans.* We know well enough how the quietest people can revel in the pages of romance. When a child's emotional make-up is changed by the books he reads, it is the real emotions, or, more often still, the ideas aroused, that do the work.

The function of the pseudo-emotions is simply to give innocent pleasure and to be symptoms that the mind is at least healthy enough to enjoy unimpeded action. With our pseudo-emotions from novels and dramas we play at love or war as our children play at keeping store or hunting bears.

Play on, children of all ages, says the wise man. Only do not imagine that you are saving your souls or remodelling your minds by the game. Play on, you who are champions, professionals, who turn play to a trade and live by your skill at it, who write essays telling how you feel as you play so that others may emulate you. Play on, but do not despise the workers in this world.

## HAND WORK

Numerous problems arise in connection with hand work in the mind of any one who is interested in the mental processes by which children learn and in the results on their make-up of different sorts of training.

Just how is manual skill acquired? Just what laws govern the growth of accurate and controlled movements? Are habits of our hands and eyes more permanent than habits of thought? Just what are the inborn tendencies that make children zealous in constructive hand work? Just why do they learn more about a square by cutting out a bad one themselves than by seeing a good one that some one else has made? Just what conditions of physical and mental growth limit the kind and quality of movements children can make, and in what ways? What is the reaction of hand work upon knowledge and self-control and attention and all the mental habits? These and other questions at once attract the scientific student of children.

With the limited time at our disposal, it seems wise to present data on only the last two questions, since they are at present subjects of discussion by teachers of manual training. What, then, has psychological investigation to say about the development of motor ability in children and the contributions of hand work to the intellectual and moral make-up of children? Let us answer the last question first.

### The Reaction of Hand Work on the Mind

Let us limit our question from the start to the direct contribution of a motor act to intellect and character, leaving one side the possible indirect influence due to the acquisition of technical skill, the preparation for a trade or profession, the relief from the harm that might result from idleness, etc. What we are talking about will become clear enough as we progress.

When a boy drives a nail or draws a straight line or bends a bit of iron to a right angle, he has certain feelings of the situation involved, of the position of his hands, the nature of the material he is working on, of the tool he is working with; as he works, new sensations come from the tools and material and from his own movements. As a medical student learns about the body he is dissecting by dissecting it, so the hand worker learns about the stuff he works on. He acquires knowledge in psychologically the same way as the observer of animals or the experimenter in a chemical laboratory. The difference is in the kind of knowledge, his being about certain material substances, tools, and movements of his own body. There is, however, another possible difference. The student of chemistry or biology may, the student of history or literature often does, satisfy his teachers with only vague, verbal, moribund acquaintance with the facts in question, while the hand worker cannot satisfy his teachers unless he has acquired real, living feelings of things which are operative in directing his movements aright. He is more likely to gain real knowledge.

On the other hand, the knowledge gained by hand work is likely to be narrow and trivial. The hardness of woods or metals, the capacities of tools, the feelings of one's fingers in drawing, — these are not the sort of facts whose possession gives insight into men and things. Their value is not for general intercourse, but for certain special dealings with one small part of nature.

But our boy drawing the straight line may acquire, besides this direct information about material, tools and his own movements, secondary ideas about his procedure. He may get a notion of accuracy, of the possibility of doing a thing precisely, or of thoroughness, of doing everything that should be done in a certain task. He may learn that to do a thing well you have to be patient and cautious and attentive and to know beforehand what you are trying to do. Of course, there is a chance to learn all such lessons in connection with a page of the spelling-book or an example in arithmetic or a game of marbles. But it is easy to avoid all or some of them in most studies, whereas the teachers of hand work tell us that it is hard to do one of their tasks satisfactorily without learning them. It would, at least, seem harder than in the other studies.

The mistake must not be made, however, of supposing that

there is any necessity or even high probability that these most valuable general ideas will come from acts of manual skill. But there is an opportunity for them which teachers of hand work may improve. As to the claim that hand work excels other studies in this particular, there is little evidence. On *a priori* grounds one would perhaps surmise that for young children it did. On the other hand, one would perhaps surmise that the idea of industry or accuracy or order gained from hand work would be less likely to transfer itself to other fields and be operative in other connections than would the same idea gained from work in science.

The scholar who takes a course in manual training under wise guidance acquires from the work not only the special information and, possibly, the general ideas so far described, but also a lot of habits, perseverance, orderliness, muscular control, etc. There has been a tendency to confuse the habit, say of perseverance, in particular sorts of tasks, which does accrue as a result of hand work, and the habit *in general,* which neither manual training nor any other school study does much to advance. We do not reform the mental constitution and moral habits of children by courses in hand work or in anything else, and it is time to stop making believe that we do. The habits acquired do not extend far beyond the particular sorts of circumstances in which they were formed. The same is true of the powers, such as adroitness, executive ability, artistic appreciation, which manual work may develop. They are narrowly confined to the particular sort of data with which the student has worked. Appreciation of design, yes perhaps, but appreciation of poetry or music, no!

The scholar's experience with hand work may further provide him permanent interests of a desirable sort, interests in construction, design, technical skill, the lives and conditions of artisans and manual workers of all sorts.

We have said nothing of any "energizing of the brain centres," "strengthening of the will," or "beneficial reaction of the body on the mind." We have not invoked as the triumph of participation in manual work any mysterious transformations of personality due to the connected training of body and mind, movements and thought. And for the very good reason that all such talk would be rhetoric, not science. What happens to the person who performs intelligently an act of manual skill is a

simple matter summed up in the words harmless occupation, technical skill, knowledge of material, movements and tools, general ideas and ideals, habits, powers, and interests. Nothing more wonderful happens to him than when he speaks or writes or reads or plays. Comprehension of the effects of hand work upon the worker has been hindered by the failure to see that in their general nature and influence movements of the hands in the manual training class work were nowise different from movements of the eyes, throat muscles and legs, from movements of the hands in writing or playing the piano or juggling. The physical and mental processes involved in a piece of hand work are in their general constitution precisely similar to those involved in reading, writing or arithmetic. In all cases there is control of movements by feelings, and acquisition of feelings through the movements. In all, movements occur as expressions of the person's mind and as agents which provide new experiences for it. No generally different sort of result will come from one that doesn't from another. The differences will be in the particular skill, particular knowledge, particular habits, etc. In the olden time it was fashionable to adore those forms of life where the body was little in evidence. Now we are zealous to have as obvious bodily expression as we can. But the bodily expression was and is always present; the mind never worked apart from it. We require no separate and new psychology for manual training.

So much for the reaction upon the mind of the hand work process taken by itself alone. It is, however, generally a process that is engaged in making something which shall express some knowledge or feeling gained elsewhere. The boy does not draw lines or nail nails; he draws a canoe or nails together a house. The act of thus constructing a presentation of some idea or feeling tends to clarify the idea, make it permanent and vigorous, and to show in high lights any obvious inadequacies or errors in it. But we must not forget that children can know things without being able to draw or model them, and that they can often draw or model them excellently and know little about them. We must not forget that many a pupil can learn far more of an object in an hour spent over other people's drawings than by drawing for an hour himself. Drawing, modelling, etc., as means of expression of the ideas and feelings acquired in other courses are not panaceas, but specific drugs, to be used only under certain conditions. They are excellent servants, but very bad masters.

Let no one think that this entire analysis of ours implies anything in the least derogatory to hand work. If we find that, after all, the process is in line with all of mental life, has no mysterious private brand of excellencies, it should strengthen our confidence in its fitness as a school subject. Hand work does as much as the other school subjects for general mental development and needs no eccentric hypotheses or extravagant claims.

## The Adjustment of Hand Work to the Capacities of Children

The attention of teachers of hand work has recently been called to the need of taking into account in planning courses of study the possible incapacity of young children to make fine finger movements. The question of the growth of motor ability in children is of broader reference than merely to the drawing, cutting, pasting, sewing and modelling in manual training courses. It bears equally upon early work in reading, enunciation and writing. Just as the fitness of topics and treatment in mathematics, history, geography and other sciences is conditioned by the mental capacities of children, so the fitness of all work involving movements is conditioned by their powers of motor coördination and control. The occupations of the kindergarten, the common practice of early instruction in reading from books and writing with pencil, have all been criticised as procedures that require of children precision that is beyond the proper scope of their immature nervous systems.

The problem is really a complex one, and is by no means yet settled. The first step, however, the determination of the changes in the motor abilities of young children with age, has been taken. Important passages from Bryan's "Voluntary Motor Ability"[1] and Hancock's "Motor Ability"[2] are here reprinted. Such facts as they furnish must, when properly interpreted, be taken into account in any discussion of courses or methods that involve fine movements or a high degree of bodily control on the part of young children.

We must first recall a few simple anatomical facts and

[1] *American Journal of Psychology*, Vol. V, pp. 123–204.
[2] *Pedagogical Seminary*, Vol. III, pp. 9–21.

familiarize ourselves with one or two terms. All movements are due to the contraction (that is, the shortening and thickening), or the relaxation (that is, the lengthening), of muscles. In all the performances of which we shall treat, in all those acts which we ordinarily call acts, the muscles contract because of a stimulus given them by nerve-cells in the central nervous system (motor cells). Motor ability, then, depends not only on muscles, but also on motor nerve-cells. Now the nerve-cells which conduct the stimuli to the muscles are themselves set in action by other nerve-cells, the action of which corresponds to our sensations, ideas, etc. So that our actions depend on (1) the connections of our brain cells in general with the motor cells, (2) on the proper functioning of the latter, and (3) on the proper functioning of the muscles. A person may fail to put a key in the keyhole (1) because he has never learned that it goes there, has never formed any connection between (*a*) the nerve-cells corresponding to the sight of the key and keyhole and (*b*) the motor cells leading to the muscles that move his arm and fingers. He may fail also (2) because the motor cells in question are absent, not fully developed, diseased or temporarily paralyzed. He may fail finally (3) because the muscles in question are absent or out of order.

When several muscles contract together at the same time or in series, so as to produce some definite movement, we call the fact coördinated action. When several movements together subserve some definite end, we call the fact coördinated movement. Coördination is evidently due to the connections of our brain cells in general with the motor cells. That person coördinates his movements in writing whose brain is possessed of connections between the cell processes going with hearing dog, cat, etc., and the motor cell processes leading to the muscular contractions that make one write dog, cat, etc.

Such coördinations are of the highest importance. The acts thus brought to pass keep us alive and happy. Without them we should be mere hulks of flesh. They are also means to knowledge. They put us in situations where we get new information. They also are signs of the general condition of the brain.

In the number and delicacy and complexity of the coördinated movements that he can make the infant differs from the baby, the baby from the child, the child from the adult. We have,

therefore, to ask, What movements can children at different stages of their development make? Various observers have added to and rendered more definite our common knowledge that in the early years, the first sixteen surely, perhaps more, there is a progress toward a greater number and delicacy and complexity of coördinations. The two most important of such studies we may now examine.

## *W. L. BRYAN: VOLUNTARY MOTOR ABILITY*

*American Journal of Psychology,* Vol. V, No. 2 (Nov., 1892).

[Bryan tested the rapidity with which children of different ages could make the movement of tapping with a telegraph key. The movement was made in four ways: (1) by moving the upper arm up and down and hitting the key with the elbow, (2) by moving the forearm up and down and hitting the key with the under side of the forearm just back of the wrist, (3) by moving the hand up and down and hitting the key with the palm, (4) by moving the forefinger up and down and hitting the key with it. To quote the more exact account by Mr. Bryan: —]

All the joints of the upper extremities were tested. The conditions of the tests were as follows:

*Shoulder.*

The forearm being held at right angles to the upper arm, and the back of the elbow being held in position above the button of the Morse key, the upper arm was caused to move up and down as rapidly as possible in a plane nearly parallel with the vertical plane of the body, i.e., in about that plane in which the arm tends to swing when one walks.

*Elbow.*

The elbow rested upon the table. The forearm was held at right angles to the upper arm. The key was struck with the ventral side of the forearm just back of the wrist. In a few instances the arm was extended and while the elbow rested upon the table, as before, the taps were made with the little-finger side of the wrist. No difference appeared in the rate of the two motions. It is to be noted that the school experiments were made with the ordinary (spring) clothing about the arm. In my own case, the removal of my coat made no discernible difference in the rate of elbow or shoulder, owing, I think, to the great disproportion between the force of the limb in movement and the resistance which ordinary clothing presents.

*Wrist.*

The elbow rested upon the table. An iron clamp, whose jaws were covered with firm cushions of cloth over cotton, was placed rather loosely about the forearm just back of the wrist joint, and was held in position by an ordinary stative. The key was struck with the palm of the hand.

*Metacarpo-Phalangeal Joint of Forefinger.*

The palm of the hand was held with moderate firmness at an angle of about 135° with the forearm. The finger in position was then nearly or quite parallel with the forearm. In this way possible sympathetic movements of the wrist were prevented from affecting the record. If properly placed, the clamp does not interfere in the least with free movement of the finger. Other phalangeal joints were tested only in the case of adults. A narrow clamp was then used and, as in the case of the hand, interference with other joints was prevented in part by the position in which the member was held.

In all the experiments reported in this paper, the maximum number of taps in five seconds was determined, and all results are given in terms of $x$ taps in five seconds. * * * * * * *

Seven hundred and eighty-nine school children of the city of Worcester, Mass., ranging in age from 5 to 16 years, were tested with the apparatus and by the method described. The shoulder, elbow, wrist and metacarpo-phalangeal joint of the forefinger on each side were so tested.

*Classification of Results.*

Forty-six individuals (twenty-six boys and twenty girls) were more or less left handed. Their records are taken account of separately (175). Twenty individuals (fourteen boys and six girls) of five years of age were tested. The boys' record is printed in Table VI. The principal calculations and results of this paper refer to the 723 right-handed individuals ranging in age from 6 to 16. The 5,784 single results obtained from these individuals were classified according to the age and sex of the individual, and according to the side and joint used.

*Method of Treating Results.*

The several results belonging to each class, — for example, to the right finger of the boys of six, — were tabulated so as to show the different rates found in that class (Column 1, Table V) and the number of times each of these rates occurs (Column 2). Each rate found was multiplied by the number of times it occurs, and the sum of these products (Column 3) was divided by the sum of individual cases. The differences between this result, the arithmetical mean, and each rate found were taken (Column 4), and these residuals were squared (Column 5). Each squared residual was multiplied by the number of times the corresponding rate occurs. The sum of these weighted squared residuals (Column 6) was divided by the number of individual cases. The square root of this quotient is the mean individual variation, showing the limits of distance from the mean, within which 68.3% of the individual results fall. This

individual mean variation divided by the square root of the number of cases, gives the mean variation of the mean. The probability is .683 that the true mean lies within the limits thus determined.

The tabulation and calculation for boys' right finger, 6, are given as an example [in Table V]. $A$ designates the arithmetical mean; $\mu$ the mean individual variation, and $\mu_o$ the mean variation of the mean. The values of $A$, $\mu$, and $\mu_o$, for each class, are given in Table VI.

[The serious student should not be prevented from a thorough study of the facts of Bryan's research by the dry tabular form in which they are presented. Progress in gaining accurate information about children requires some ability to appreciate a mathematical presentation of results, and the figures in the tables to follow are infinitely more instructive than general verbal statements, once the student gains the power of reading them intelligently. Bryan's paper is one of the few which do not mix facts with inferences, or mutilate their fulness in rough statements, or fail to give exact measure of their reliability. If the reader fails to find it valuable, it testifies to his own ignorance or lack of interest in the problem.]

TABLE V

| R. Rates found | T. Times each rate was found | R. × T. | V. Difference between each rate found and their average $A$ | $V^2$. | $V^2 \times T$. |
|---|---|---|---|---|---|
| 15 | 1 | 15 | 4.5 | 20.25 | 20.25 |
| 16 | 1 | 16 | 3.5 | 12.25 | 12.25 |
| 17 | 1 | 17 | 2.5 | 6.25 | 6.25 |
| 18 | 4 | 72 | 1.5 | 2.25 | 9.00 |
| 19 | 3 | 57 | .5 | .25 | .75 |
| 20 | 10 | 200 | .5 | .25 | 2.50 |
| 21 | 3 | 63 | 1.5 | 2.25 | 6.75 |
| 22 | 2 | 44 | 2.5 | 6.25 | 12.50 |
| 23 | 1 | 23 | 3.5 | 12.25 | 12.25 |
| | 26 | 507 | | | 82.50 |

$507 \div 26 = 19.5 = A.$

$\sqrt{\frac{82.50}{26}} = 1.78 = \mu.$

$\frac{1.78}{\sqrt{26}} = .34 = \mu_o.$

[Note: — I have slightly modified the headings. — E. L. T.]

[To aid the reader in interpreting Tables V and VI, we may define $A$, $\mu$, and $\mu_o$ more clearly. $A$ (the mean) equals the average number of taps made in 5 seconds by the boys or girls of the age mentioned; $\mu$ (the mean individual variation) is a measure of the extent to which the different individuals of the sex and age under discussion varied from the average. It is clear that the same average might come from a few very quick individuals and a lot of slow ones, from a few slow ones and a lot of quick ones, from all the individuals being near the average, or from a lot of other combinations. If we took all the differences between the rates of individuals and the average rate, 68 per cent of them would be less than the amount under $\mu$. $\mu_o$ (the mean variation or error of $A$, the mean) is a measure of the reliability of the $A$, or average. This average is gained from a few cases, generally about 30. Now, if we took 60 cases instead of 30, the average might be different. $\mu_o$ is so calculated that it tells us how different our average might be if we had an infinite number of cases. If $\mu_o$, for instance, is .6 and our $A$ is 15.0, we are told by it that if we took an infinite number of cases the chances are 68 in 100 that the average then found would not differ from the $A$ we got by more than .6; that is, that the chances are 68 in 100 that the average from an infinite number of cases would be between 14.4 and 15.6.]

[The first line of Table VI, for instance, is to be interpreted thus: ($A$) 14 5-year-old boys in 5 seconds, tapping with the right finger, averaged 19.6 taps.

($\mu$) Any single right-handed 5-year-old boy that you may take will, in two cases out of three, not deviate from this rate by over 2.82 taps, will not, that is, have a rate of over 22.4 or under 16.8 taps. If we took 100 such boys at random, 68 of them would probably have rates between 22.4 and 16.8.

($\mu_o$) If instead of 14 boys we had tested all the right-handed five-year-olds there are, the chances are 2 to 1 that we should not get an average rate that would differ from 19.6 by more than 0.8. (The chances would be 20 to 1 against the average gained differing from 19.6 by more than 1.6, and 370 to 1 against its differing from 19.6 by more than 2.4.)

Throughout Table VI, n = the number of individuals tested, F = finger, W = wrist, E = elbow, S = shoulder, R = right and L = left.]

## TABLE VI

### RATE: AGE 5

| | | *Boys, n* 14. | | | *Girls, n* 6 |
|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | |
| R | F | 19.6 | 2.82 | 0.8 | |
| | W | 20.1 | 3.66 | 1.0 | |
| | E | 22.7 | 2.90 | 0.8 | |
| | S | 18.4 | 2.72 | 0.7 | |
| L | F | 17.3 | 3.34 | 0.9 | Omitted, because so few. |
| | W | 17.0 | 3.39 | 0.9 | |
| | E | 18.2 | 3.23 | 0.9 | |
| | S | 17.0 | 2.38 | 0.6 | |

### RATE: AGE 6

| | | *Boys, n* 26. | | | *Girls, n* 28 | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 19.5 | 1.78 | 0.3 | 19.8 | 2.56 | 0.5 |
| | W | 23.0 | 2.72 | 0.5 | 21.6 | 2.57 | 0.4 |
| | E | 23.5 | 1.45 | 0.3 | 22.7 | 2.33 | 0.4 |
| | S | 19.8 | 2.81 | 0.6 | 19.9 | 2.71 | 0.5 |
| L | F | 18.0 | 1.56 | 0.3 | 18.0 | 2.76 | 0.5 |
| | W | 19.7 | 2.32 | 0.5 | 18.9 | 2.33 | 0.4 |
| | E | 20.4 | 2.47 | 0.5 | 19.7 | 2.06 | 0.4 |
| | S | 18.2 | 2.34 | 0.5 | 17.9 | 2.43 | 0.5 |

### RATE: AGE 7

| | | *Boys, n* 35. | | | *Girls, n* 32 | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 21.0 | 2.64 | 0.4 | 20.7 | 2.46 | 0.4 |
| | W | 23.7 | 2.91 | 0.5 | 23.1 | 2.70 | 0.5 |
| | E | 24.2 | 3.71 | 0.6 | 23.2 | 1.95 | 0.3 |
| | S | 20.5 | 2.48 | 0.4 | 20.2 | 2.66 | 0.5 |
| L | F | 19.1 | 2.40 | 0.4 | 19.1 | 3.23 | 0.6 |
| | W | 20.2 | 2.60 | 0.4 | 20.0 | 2.46 | 0.4 |
| | E | 20.9 | 3.07 | 0.5 | 21.5 | 2.96 | 0.5 |
| | S | 18.8 | 2.50 | 0.4 | 18.8 | 2.67 | 0.5 |

RATE: AGE 8

| | | *Boys, n* 33. | | | *Girls, n* 32 | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 23.1 | 2.56 | 0.4 | 22.2 | 2.74 | 0.5 |
| | W | 26.3 | 2.83 | 0.5 | 24.3 | 2.73 | 0.5 |
| | E | 26.1 | 2.57 | 0.4 | 24.4 | 2.68 | 0.5 |
| | S | 22.3 | 2.26 | 0.4 | 21.9 | 3.08 | 0.5 |
| L | F | 20.5 | 1.91 | 0.3 | 19.7 | 2.71 | 0.5 |
| | W | 22.2 | 2.88 | 0.5 | 21.0 | 2.69 | 0.5 |
| | E | 22.3 | 2.61 | 0.4 | 21.6 | 2.27 | 0.4 |
| | S | 20.2 | 2.69 | 0.5 | 20.2 | 2.64 | 0.5 |

RATE: AGE 9

| | | *Boys, n* 43. | | | *Girls, n* 36 | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 24.4 | 4.15 | 0.6 | 24.0 | 2.69 | 0.4 |
| | W | 27.8 | 3.50 | 0.5 | 25.5 | 3.26 | 0.5 |
| | E | 28.2 | 3.52 | 0.5 | 25.4 | 3.62 | 0.6 |
| | S | 24.1 | 3.65 | 0.6 | 22.7 | 3.26 | 0.5 |
| L | F | 21.5 | 3.60 | 0.5 | 20.6 | 2.92 | 0.5 |
| | W | 23.6 | 3.84 | 0.6 | 22.4 | 2.99 | 0.5 |
| | E | 23.8 | 3.67 | 0.6 | 22.6 | 2.91 | 0.5 |
| | S | 20.9 | 3.57 | 0.5 | 20.8 | 3.79 | 0.6 |

RATE: AGE 10

| | | *Boys, n* 37. | | | *Girls, n* 35 | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 25.2 | 2.29 | 0.4 | 24.3 | 2.42 | 0.4 |
| | W | 28.5 | 3.34 | 0.5 | 25.8 | 3.36 | 0.6 |
| | E | 28.1 | 3.60 | 0.6 | 28.5 | 3.66 | 0.6 |
| | S | 22.6 | 2.75 | 0.4 | 27.5 | 2.96 | 0.5 |
| L | F | 22.4 | 3.15 | 0.5 | 22.6 | 2.76 | 0.5 |
| | W | 24.5 | 3.70 | 0.6 | 22.3 | 2.64 | 0.4 |
| | E | 24.7 | 2.74 | 0.4 | 24.0 | 2.51 | 0.4 |
| | S | 20.5 | 2.85 | 0.5 | 21.6 | 2.62 | 0.4 |

RATE: AGE 11

| | | *Boys, n 36.* | | | *Girls, n 35* | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_e$ | A | $\mu$ | $\mu_e$ |
| R | F | 27.0 | 3.60 | 0.6 | 27.1 | 3.44 | 0.6 |
| | W | 30.3 | 4.62 | 0.8 | 30.4 | 4.30 | 0.7 |
| | E | 29.3 | 3.41 | 0.6 | 28.6 | 3.44 | 0.6 |
| | S | 24.1 | 2.93 | 0.5 | 24.9 | 3.30 | 0.6 |
| L | F | 23.9 | 2.57 | 0.4 | 24.9 | 3.48 | 0.6 |
| | W | 25.9 | 3.69 | 0.6 | 26.3 | 4.02 | 0.7 |
| | E | 26.0 | 3.41 | 0.6 | 26.2 | 3.57 | 0.6 |
| | S | 21.5 | 2.57 | 0.4 | 23.6 | 3.44 | 0.6 |

RATE: AGE 12

| | | *Boys, n 33.* | | | *Girls, n 34* | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_e$ | A | $\mu$ | $\mu_e$ |
| R | F | 29.3 | 5.40 | 0.9 | 28.2 | 3.98 | 0.7 |
| | W | 31.6 | 5.27 | 0.9 | 31.6 | 5.18 | 1.0 |
| | E | 29.9 | 4.12 | 0.7 | 29.4 | 4.90 | 0.8 |
| | S | 25.0 | 3.32 | 0.6 | 25.7 | 4.35 | 0.7 |
| L | F | 26.3 | 3.84 | 0.7 | 25.8 | 3.44 | 0.6 |
| | W | 26.9 | 3.70 | 0.6 | 27.0 | 4.90 | 0.8 |
| | E | 26.3 | 3.76 | 0.6 | 26.2 | 4.56 | 0.8 |
| | S | 22.4 | 3.59 | 0.6 | 23.6 | 3.64 | 0.6 |

RATE: AGE 13

| | | *Boys, n 34.* | | | *Girls, n 34* | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_e$ | A | $\mu$ | $\mu_e$ |
| R | F | 28.7 | 3.49 | 0.6 | 30.3 | 4.52 | 0.8 |
| | W | 32.3 | 3.69 | 0.6 | 33.2 | 6.03 | 1.0 |
| | E | 31.0 | 4.44 | 0.8 | 30.5 | 6.20 | 1.1 |
| | S | 25.5 | 4.52 | 0.8 | 27.5 | 4.32 | 0.7 |
| L | F | 26.1 | 3.10 | 0.5 | 26.7 | 4.85 | 0.8 |
| | W | 27.6 | 3.72 | 0.6 | 28.6 | 4.89 | 0.8 |
| | E | 27.5 | 3.70 | 0.6 | 28.6 | 4.15 | 0.7 |
| | S | 23.7 | 3.81 | 0.7 | 25.2 | 3.83 | 0.7 |

RATE: AGE 14

| | | *Boys, n 41.* | | | *Girls, n 33* | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 31.5 | 3.69 | 0.6 | 29.5 | 3.02 | 0.5 |
| | W | 33.0 | 3.80 | 0.6 | 30.3 | 3.79 | 0.6 |
| | E | 32.7 | 4.63 | 0.7 | 28.8 | 2.83 | 0.5 |
| | S | 27.2 | 3.49 | 0.5 | 26.6 | 3.17 | 0.5 |
| L | F | 27.5 | 3.69 | 0.6 | 26.8 | 2.89 | 0.5 |
| | W | 29.0 | 2.61 | 0.4 | 28.0 | 3.70 | 0.6 |
| | E | 28.6 | 3.62 | 0.6 | 26.9 | 3.48 | 0.6 |
| | S | 24.3 | 3.49 | 0.5 | 23.8 | 3.34 | 0.6 |

RATE: AGE 15

| | | *Boys, n 32.* | | | *Girls, n 31* | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 31.6 | 4.02 | 0.7 | 29.1 | 3.44 | 0.6 |
| | W | 34.2 | 4.46 | 0.8 | 30.9 | 4.31 | 0.8 |
| | E | 31.5 | 3.72 | 0.7 | 29.3 | 3.84 | 0.7 |
| | S | 26.3 | 3.29 | 0.6 | 26.0 | 3.89 | 0.7 |
| L | F | 28.3 | 3.46 | 0.6 | 26.7 | 3.23 | 0.6 |
| | W | 29.5 | 3.60 | 0.6 | 28.3 | 3.97 | 0.7 |
| | E | 28.7 | 3.61 | 0.6 | 27.6 | 4.01 | 0.7 |
| | S | 24.7 | 3.58 | 0.6 | 25.4 | 4.14 | 0.7 |

RATE: AGE 16

| | | *Boys, n 26.* | | | *Girls, n 17* | | |
|---|---|---|---|---|---|---|---|
| | | A | $\mu$ | $\mu_o$ | A | $\mu$ | $\mu_o$ |
| R | F | 33.9 | 4.92 | 1.0 | 31.3 | 4.66 | 1.1 |
| | W | 35.9 | 5.16 | 1.01 | 30.1 | 4.93 | 1.09 |
| | E | 32.7 | 3.90 | 0.8 | 33.3 | 4.52 | 1.2 |
| | S | 28.7 | 3.42 | 0.7 | 27.9 | 3.44 | 0.8 |
| L | F | 30.7 | 5.08 | 1.0 | 28.6 | 4.01 | 1.0 |
| | W | 33.1 | 4.70 | 0.9 | 29.5 | 3.87 | 0.9 |
| | E | 30.7 | 2.68 | 0.5 | 28.2 | 3.75 | 0.9 |
| | S | 26.6 | 3.52 | 0.7 | 26.2 | 3.55 | 0.8 |

*The Degree of Trustworthiness of Results.*

I have endeavored to state fully the conditions under which the foregoing tests were made, so that the *a priori* probability of their trustworthiness might be estimated. There are, however, two ways of determining from the results themselves their probable degree of trustworthiness. From whatever known or unknown sources of error the work may have suffered, the net errors are probably within the limits thus ascertained.

1. The mean errors of the means.

Inspection of the tables or charts shows that the limits of mean errors of the means are in all cases absolutely small, and small in comparison with the values of the corresponding means. Further examination shows:

| | |
|---|---|
| Average of the 160 values of $\mu_0$ for ages 6–15 | .57 taps in 5 seconds |
| Sixty-eight per cent of these values range from 0 to | .67 " " " " |
| Maximum value of $\mu_0$ | 1.1 " " " " |

Seventy-seven per cent of the values of $\mu_0$ are less than 2% of their corresponding means.

In sum, if an equal number of individuals, corresponding in age and sex to any class for whom means are here given, be tested under the same conditions, the probability is .683 that the resulting mean will not differ from that here given by more than .67 taps in 5 seconds, and the probability is .978 that the resulting mean will not differ from that here given by more than one tap in 5 seconds.

The relatively small number of individuals of 16 upon whom measurements could be obtained renders the means at that age somewhat less reliable:

| | |
|---|---|
| Average value of $\mu_0$ for age 16 | .9 taps in 5 seconds |
| Maximum value of $\mu_0$ | 1.2 " " " " |
| Average $\frac{\mu_0 . 100}{A}$ | .3% " " " " |

2. An independent means of judging the degree of trustworthiness of the means is furnished by a comparison of the results from boys with those from girls. It cannot be assumed, and is in fact later shown to be untrue, that the rates for boys and for girls of the same age are approximately equal. On the contrary, there appear clearly defined differences varying with the age examined. But if, the fact of characteristic differences between the two sexes having been established, it should appear that the two sets of wholly independent means differ from each other within very narrow limits, then it is probable that two sets of independent means obtained from individuals of the same sex would differ from each other within still narrower limits, certainly not wider ones. If the values of B—G) for the 88 possible comparisons (11 ages, 8 joints) between corresponding mean rates of boys and girls be determined, the

differences in the mean rates of boys and girls is shown to be very small. Of the 88 values of (B—G),

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | differ | by | 3 | taps | or | over | in | 5 | seconds |
| 14 | " | " | 2 | " | " | " | " | 5 | " |
| 19 | " | " | 1 | " | " | " | " | 5 | " |
| 52 | " | " | less | than | 1 | tap | in | 5 | " |

In 59 of 88 cases, $(B—G) < (\mu_e B + \mu_e G)$

That is, in 67% of the cases the difference between the mean rate for boys and the corresponding rate for girls is within the limits of the mean errors of the means compared.

*Mean Variation:* It will be noted that the mean individual variation is subject to considerable fluctuation. Examination shows that periods of most rapid acceleration are generally periods of widening individual variation, while periods of greatest retardation or decline are periods of narrowing individual variation. The mean individual variation rarely (seven times out of 184) exceeds one tap per second.

* * * * * * * *

*Variation of Rate with Age.*

Inspection of the tables or charts shows for both sexes and for all joints an increase of rate with age. The total amount of increase in the rate of each joint in the ten years from 6 to 16 is shown in the following table. A change in decimal point gives the average yearly increase.

Total increase in rate between ages 6 and 16, in terms of x taps in 5 seconds:

| | | | | |
|---|---|---|---|---|
| Boys' right | F., 14.4; | W., 12.9; | E., 9.2; | S., 8.9. |
| Boys' left | F., 12.7; | W., 13.3; | E., 10.3; | S., 8.4. |
| Girls' right | F., 11.5; | W., 8.5;* | E., 7.4;* | S., 8.0. |
| Girls' left | F., 10.6; | W., 10.6; | E., 8.5;* | S., 8.3. |

* Higher at 13 than at 16.

The amount of increase is not, however, the same each year. Table VII gives the amount of increase or decrease for each joint in each year period. Table VII*a* shows the periods of most obvious acceleration and retardation of growth.

TABLE VII

*Showing amount of increase or decrease in the rate of each joint each year from 6–16 in terms of x taps in 5 seconds*

| AGES | | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boys' Right | F | 1.5 | 2.1 | 1.3 | .8 | 1.8 | 2.3 | —.6 | 2.8 | .1 | 2.3 |
| | W | .7 | 2.6 | 1.5 | .7 | 1.8 | 1.3 | .7 | 1.5 | .4 | 1.7 |
| | E | .7 | 1.9 | 2.1 | —.1 | 1.2 | .6 | 1.1 | 1.7 | —1.2 | 1.2 |
| | S | .7 | 1.8 | 1.8 | —1.5 | 1.5 | .9 | .5 | 1.8 | .9 | 2.5 |
| Boys' Left | F | 1.1 | 1.4 | 1.0 | .9 | 1.5 | 2.3 | —.2 | 1.4 | .8 | 2.4 |
| | W | .5 | 2.0 | 1.4 | .9 | 1.4 | 1.0 | .7 | 1.4 | .5 | 3.6 |
| | E | .5 | 1.4 | 1.5 | .9 | 1.3 | .3 | 1.2 | 1.1 | .1 | 2.0 |
| | S | .6 | 1.4 | .7 | .4 | 1.0 | .9 | 1.3 | .6 | .4 | 2.1 |
| Girls' Right | F | .9 | 1.5 | 1.8 | 1.8 | 1.3 | 1.1 | 2.1 | —.8 | —.4 | 2.1 |
| | W | 1.5 | 1.2 | 1.2 | 3.0 | 1.9 | 1.2 | 1.6 | —2.9 | .6 | —.8 |
| | E | .5 | 1.2 | 1.0 | 2.1 | 1.1 | .8 | .9 | —1.7 | .5 | .8 |
| | S | .3 | 1.7 | .8 | —.1 | 2.3 | .8 | 1.8 | —.9 | —.6 | 1.9 |
| Girls' Left | F | 1.1 | .6 | .9 | 1.7 | 2.6 | .9 | .9 | .1 | —.1 | 1.9 |
| | W | 1.1 | 1.0 | 1.4 | 1.9 | 2.0 | .7 | 1.6 | —.6 | .3 | 1.2 |
| | E | 1.8 | .1 | 1.0 | 1.4 | 2.2 | .0 | 2.4 | —1.7 | .7 | .6 |
| | S | .9 | 1.4 | .6 | .8 | 2.0 | .0 | 1.6 | —1.4 | 1.6 | .8 |

TABLE VII*a*

Every joint shows an increase greater than the average yearly increase for that joint:

In boys, at ages 7-8, 10-11, 15-16. In girls, 10-11.

Seven of the eight joints show accelerated growth:

In girls, 12-13.

Six of the eight joints show accelerated growth:

In boys, 13-14. In girls, 9-10.

Five of the eight joints show accelerated growth:

In boys, 8-9, 11-12. In girls, 6-7, 7-8, 8-9, 15-16.

Five of the eight joints show an increase of rate less than the average yearly increase for that joint, or a decrease:

In boys, 12-13. In girls, 11-12.

Seven of the eight joints show retardation, or decrease:

In boys, 6-7. In girls, 14-15.

Eight joints show retardation, or decrease:

In boys, 9-10, 14-15. In girls, 13-14.

It is obvious from the tables ***** that there are certain periods when all or nearly all the joints grow at an accelerated rate, and other periods when all or nearly all grow at a retarded rate or even decline in ability; and it is clear what those periods are. Table VII*a*. The periods

of most considerable and most significant decline are for boys from 14 to 15 and for girls from 13 to 14. It will be observed that in each of these cases the period of decline is preceded by a period of acceleration and is followed by a more or less rapid recovery.

[It is of some theoretical importance to know whether the increase in rapidity is as great for the left side of the body as for the right. Between 6 and 16 years the right finger movement does improve faster than the left, so that it is, in the case of the boys, 1.7 taps farther ahead of it at 16 than at 6.

In the case of the girls it is .9 taps farther ahead. The elbow loses in both boys and girls. The wrist and shoulder vary. The figures are:

| | | | | |
|---|---|---|---|---|
| Boys | F., 1.7; | W., —.4; | E., —1.1; | S., .5 |
| Girls | F., .9; | W., 1.1; | E., —1.1; | S., —.3 |

These differences are, however, very slight in comparison with the total gain.

It is also important to know whether the different movements of shoulder, elbow, wrist and finger gain equally or not. They do not. The wrist and finger movements gain in rapidity much faster than the shoulder and elbow movements. The increase in speed for boys from 6 to 16 years is, in percentages:

| | | |
|---|---|---|
| Finger | Right 73% | Left 77% |
| Wrist | " 56 " | " 67 " |
| Elbow | " 48 " | " 50 " |
| Shoulder | " 45 " | " 46 " |

The finger thus makes about one and one-half as much improvement as the shoulder.]

[Bryan also tested the precision of movement in children of different ages in the following manner:]

SCHOOL TESTS ON PRECISION

*Writing Movement.*

With a few exceptions, the same pupils tested in the rate experiments were tested for precision.

Apparatus: Strips of platinum foil were pasted smoothly on plate glass so as to make an angle of 2½ degrees. A small steel needle, set in a common wooden penholder, served as stylus. Three to four Le Clanche cells constituted the battery. A telegraph sounder gave the signal when the needle touched the platinum.

Course of the Experiments: The child was seated in front of the table where the glass plate lay. The latter was placed in such a position that the line along which the stylus was to be drawn should make an angle of 45°-50° with the frontal plane of the subject, when the right hand was used; and an angle of 130°-135°, when the left hand was to be used. The stylus was in each case placed between the arms of the instrument, 30 mm. from the 0 point, and drawn toward the 0 point until contact was made. Six trials were made with each hand, three movements in each case being made away from the body, and three toward the body. The point of contact was recorded. The child learned what he was expected to do as follows: (*a*) In nearly every case he looked on while one or more of his comrades went through the tests. (*b*) He received plain directions, e.g., "Take the pen; hold it so; put the point here; draw the pen so, without touching either side," etc. (*c*) He was made to try several times, until it was quite certain that he knew what he was expected to do. In some cases with very small and very stupid children, it proved impossible to make them understand what they were expected to do. Such cases, after long and patient trial, were abandoned. But records were not excluded because of being unusually inaccurate, if it could be ascertained from the child's answers and efforts that he knew what to try to do. The entire series of precision tests in the schools of Worcester was taken with scrupulous attention to every detail by my wife, Mrs. Lotta Lowe Bryan.

[Dr. Bryan's quantitative expression of the growth in precision with age is somewhat complicated. He says:]

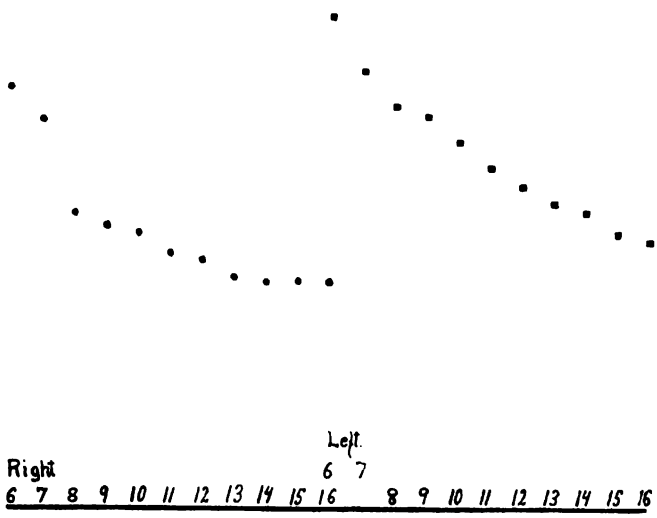
The results were classified according to the age and sex of the subjects, according to the hand used, and according to the direction of movement. Each class of results was treated by the method described, page 180. The Table XX gives the result. The numbers before the colons give the numerical weights of the results after the colons; the latter give twice the distance in mm. within which 68% of deviations fall. Results with a weight of 150 or more are printed in heavy type.

[The first line of Table XX should thus read: "About the accuracy of six-year-old boys with a downward movement of the right hand between 1 and 5 mm. on the scale of the apparatus, we have no information; between 6 and 10 mm. on the scale of the apparatus they deviate from they straight line they are trying to draw to such an extent that a band .69 of a millimetre wide would contain 68% of their lines. That is, in 68% of their trials they do not go over .345 mm. to one side or the other of the straight line. The weight of this information, its importance as a contribution to our knowledge of the precision of movement of six-year-olds, is 17. Between 11 and 15 mm. on the scale, the six-year-

olds deviate from the straight line they are trying to draw to such an extent that a band .45 mm. wide would contain 68% of their lines. That is, in about 2 cases out of every 3 they do not move the pen more than .225 mm. to one side or the other of a straight line. The weight of this information, its importance as a contribution to our knowledge, is 152. So on for the rest of the table.]

[The reader need not pay special attention to the numbers expressing the weights or importance of the different degrees of precision found in different parts of the scale. He will not be misled to any considerable extent if he uses only the figures under mm., which represent the lack of precision.]

[I have made from these data an approximate representation of the growth of precision in a diagram. The height of the points above the line represents roughly the average in accuracy of the movements tested at the different ages. For the accurate de-




*Growth in precision of writing movement; right and left hands.*

termination of any question, however, the tables are far better. Mr. Bryan's conclusions from them are, in part, as follows:]

Although three times as many experiments were made upon an individual in each set of precision tests as in the rate tests, and although by the method of treatment each single trial by the pupil furnished in-

## TABLE XX

*School Tests on Precision*

| Part of Scale | | I 1–5 | II 6–10 | III 11–15 | IV 16–20 | V 21–25 | VI 26–30 |
|---|---|---|---|---|---|---|---|
| | Age | W't mm | W't mm | W't mm | W't mm | W't mm | W't mm |
| Boys' Right Down | 6 | — | 17 : .69 | 152 : .45 | 304 : .44 | 229 : .43 | — |
| | 7 | — | 62 : .40 | 237 : .38 | 424 : .41 | 302 : .39 | — |
| | 8 | 15 : .23 | 168 : .30 | 399 : .30 | 490 : .33 | — | — |
| | 9 | 49 : .16 | 283 : .26 | 508 : .30 | 610 : .31 | — | — |
| | 10 | 45 : .25 | 251 : .26 | 472 : .29 | 214 : .35 | — | — |
| | 11 | 84 : .14 | 305 : .24 | 504 : .26 | 108 : .25 | — | — |
| | 12 | 61 : .17 | 247 : .26 | 423 : .28 | 285 : .27 | — | — |
| | 13 | 153 : .17 | 401 : .19 | 294 : .21 | 203 : .28 | — | — |
| | 14 | 173 : .14 | 433 : .20 | 571 : .23 | 238 : .27 | — | — |
| | 15 | 71 : .17 | 293 : .24 | 455 : .25 | 96 : .29 | — | — |
| | 16 | 48 : .27 | 256 : .23 | 366 : .25 | 78 : .28 | — | — |
| Boys' Right Up | 6 | — | 25 : .54 | 155 : .44 | 326 : .43 | 154 : .38 | — |
| | 7 | — | 72 : .45 | 263 : .38 | 448 : .40 | 203 : .36 | — |
| | 8 | 10 : .26 | 163 : .33 | 370 : .34 | 196 : .32 | — | — |
| | 9 | 39 : .16 | 246 : .29 | 524 : .31 | 374 : .28 | — | — |
| | 10 | 22 : .23 | 208 : .31 | 466 : .31 | 214 : .29 | — | — |
| | 11 | 45 : .27 | 288 : .27 | 504 : .27 | 108 : .30 | — | — |
| | 12 | 70 : .17 | 302 : .24 | 366 : .26 | — | — | — |
| | 13 | 80 : .16 | 333 : .25 | 392 : .24 | — | — | — |
| | 14 | 118 : .16 | 421 : .22 | 571 : .22 | 120 : .25 | — | — |
| | 15 | 120 : .19 | 398 : .20 | 191 : .22 | — | — | — |
| | 16 | 97 : .19 | 323 : .22 | 231 : .21 | — | — | — |
| Boys' Left Down | 6 | — | — | 62 : .59 | 171 : .54 | 305 : .54 | 78 : .53 |
| | 7 | — | — | 52 : .50 | 218 : .57 | 411 : .52 | 297 : .52 |
| | 8 | — | 31 : .52 | 165 : .41 | 358 : .48 | 476 : .41 | 99 : .42 |
| | 9 | — | 59 : .36 | 215 : .45 | 484 : .45 | 609 : .41 | — |
| | 10 | — | 73 : .42 | 248 : .38 | 462 : .42 | 320 : .38 | — |
| | 11 | 4 : .66 | 83 : .35 | 253 : .36 | 463 : .44 | — | — |
| | 12 | 9 : .20 | 114 : .33 | 320 : .37 | 462 : .34 | — | — |
| | 13 | 33 : .32 | 200 : .24 | 360 : .39 | 381 : 35 | — | — |
| | 14 | 13 : .20 | 184 : .30 | 418 : .33 | 556 : .34 | 239 : .34 | — |
| | 15 | 47 : .19 | 263 : .25 | 412 : .27 | 282 : .31 | 96 : .34 | — |
| | 16 | 31 : .30 | 194 : .24 | 310 : .24 | 228 : .33 | — | — |
| Boys' Left Up | 6 | — | 10 : .63 | 57 : .48 | 166 : .56 | 289 : .56 | 231 : .53 |
| | 7 | — | 43 : .36 | 128 : .40 | 283 : .49 | 427 : .48 | 299 : .51 |
| | 8 | — | 42 : .40 | 181 : .40 | 342 : .47 | 453 : .45 | 201 : .51 |
| | 9 | 8 : .26 | 104 : .32 | 287 : .37 | 498 : .45 | 615 : .41 | 129 : .44 |
| | 10 | 26 : .20 | 135 : .26 | 295 : .35 | 464 : .39 | 318 : .41 | — |
| | 11 | 11 : .20 | 93 : .37 | 298 : .34 | 473 : .40 | 214 : .36 | — |
| | 12 | 38 : .16 | 122 : .29 | 328 : .35 | 458 : .36 | 96 : .35 | — |
| | 13 | 58 : .17 | 223 : .22 | 377 : .29 | 471 : .34 | 302 : .37 | — |
| | 14 | 94 : .16 | 263 : .22 | 460 : .32 | 572 : .32 | 120 : .33 | — |
| | 15 | 56 : .17 | 242 : .26 | 406 : .27 | 575 : .30 | — | — |
| | 16 | 59 : .19 | 219 : .22 | 348 : .28 | 231 : .29 | — | — |

TABLE XX — *Continued*

*School Tests on Precision*

| Part of Scale | | I 1–5 | II 6–10 | III 11–15 | IV 16–20 | V 21–25 | VI 26–30 |
|---|---|---|---|---|---|---|---|
| | Age | W't mm | W't mm | W't mm | W't mm | W't mm | W't mm |
| Girls' Right Down | 6 | 3 : .48 | 56 : .29 | 212 : .43 | 387 : .40 | — | — |
| | 7 | — | 41 : .53 | 224 : .42 | 399 : .40 | 274 : .39 | — |
| | 8 | 21 : .24 | 182 : .23 | 352 : .32 | 359 : .33 | — | — |
| | 9 | 24 : .21 | 171 : .27 | 394 : .32 | 506 : .31 | — | — |
| | 10 | 35 : .22 | 243 : .24 | 449 : .31 | — | — | — |
| | 11 | 89 : .18 | 344 : .24 | 487 : .27 | — | — | — |
| | 12 | 74 : .16 | 235 : .22 | 422 : .30 | 500 : .30 | — | — |
| | 13 | 53 : .21 | 265 : .26 | 463 : .26 | 102 : .28 | — | — |
| | 14 | 92 : .13 | 304 : .22 | 355 : .24 | 378 : .30 | — | — |
| | 15 | 56 : .21 | 294 : .22 | 330 : .27 | 366 : .30 | — | — |
| | 16 | 15 : .31 | 142 : .26 | 188 : .28 | — | — | — |
| Girls' Right Up | 6 | — | 79 : .34 | 218 : .43 | 307 : .43 | 83 : .41 | 84 : .43 |
| | 7 | — | 82 : .36 | 265 : .39 | 427 : .37 | 185 : .35 | — |
| | 8 | 17 : .31 | 169 : .29 | 363 : .29 | 361 : .32 | — | — |
| | 9 | 26 : .30 | 191 : .27 | 411 : .34 | 313 : .32 | — | — |
| | 10 | 38 : .27 | 294 : .34 | 476 : .25 | 203 : .28 | — | — |
| | 11 | 48 : .24 | 306 : .27 | 506 : .25 | — | — | — |
| | 12 | 55 : .25 | 283 : .25 | 453 : .27 | 303 : .27 | — | — |
| | 13 | 80 : .18 | 341 : .23 | 390 : .24 | — | — | — |
| | 14 | 86 : .20 | 354 : .22 | 460 : .22 | 96 : .29 | — | — |
| | 15 | 75 : .22 | 321 : .23 | 264 : .23 | 93 : .29 | — | — |
| | 16 | 69 : .15 | 213 : .22 | — | — | — | — |
| Girls' Left Down | 6 | — | 4 : .50 | 82 : .48 | 202 : .50 | 356 : .57 | 84 : .45 |
| | 7 | — | 8 : .35 | 122 : .45 | 287 : .49 | 434 : .48 | 93 : .42 |
| | 8 | — | 25 : .34 | 147 : .48 | 365 : .48 | 275 : .40 | — |
| | 9 | — | 33 : .43 | 172 : .43 | 383 : .51 | 318 : .42 | — |
| | 10 | — | 42 : .36 | 176 : .44 | 413 : .47 | 203 : .38 | — |
| | 11 | — | 79 : .31 | 276 : .41 | 465 : .38 | 465 : .38 | 105 : .40 |
| | 12 | 3 : .21 | 72 : .34 | 253 : .40 | 440 : .43 | 203 : .34 | — |
| | 13 | 9 : .74 | 146 : .30 | 351 : .35 | 482 : .34 | — | — |
| | 14 | 7 : .57 | 169 : .31 | 348 : .31 | 447 : .32 | 191 : .41 | — |
| | 15 | 28 : .22 | 176 : .24 | 323 : .32 | 427 : .34 | 184 : .39 | — |
| | 16 | 6 : .48 | 122 : .27 | 212 : .32 | 150 : .33 | — | — |
| Girls' Left Up | 6 | — | 23 : .40 | 83 : .44 | 202 : .54 | 370 : .55 | 84 : .48 |
| | 7 | — | 7 : .49 | 86 : .40 | 265 : .53 | 343 : .47 | — |
| | 8 | 9 : .34 | 62 : .27 | 208 : .42 | 348 : .42 | 447 : .44 | — |
| | 9 | — | 56 : .40 | 208 : .39 | 401 : .42 | 505 : .45 | 108 : .41 |
| | 10 | 17 : .27 | 102 : .28 | 239 : .35 | 421 : .42 | 298 : .42 | — |
| | 11 | 57 : .13 | 178 : .23 | 338 : .32 | 451 : .37 | 410 : .39 | — |
| | 12 | 34 : .22 | 148 : .26 | 347 : .32 | 465 : .34 | 303 : .39 | — |
| | 13 | 23 : .12 | 136 : .28 | 335 : .34 | 470 : .36 | 203 : .39 | — |
| | 14 | 17 : .21 | 146 : .32 | 316 : .33 | 342 : .35 | 281 : .38 | — |
| | 15 | 24 : .18 | 169 : .27 | 348 : .32 | 345 : .32 | 366 : .37 | — |
| | 16 | 21 : .27 | 124 : .25 | 222 : .27 | 99 : .32 | 31 : .33 | — |

formation as to the precision at many points in its course, so that the numerical weights of the precision results are many times greater than the numerical weights of the rate results, — yet the former are still insufficient to define clearly the amounts of yearly growth. This result, which evidently comes from the much greater variability in the power to make precise movements than in the power to move at a maximum rate, is itself significant; but it limits greatly the possibility of deriving trustworthy conclusions concerning the development of precision of movement. In the following, only those conclusions will be given which stand apparently clear of doubt, in connection with all information possessed by the author for determining the several degrees of probability.

*Variation in the Precision at Different Parts of the Scale.*

It may be observed in almost every set of results that the mean precision increases as the apex of the angle is approached. This does not, of course, mean that fewer touches per hundred trials are made, but fewer, in proportion to the space between the arms of the instrument. It seems probable that this is due to the more perfect concentration of attention as the task becomes more difficult. In all comparisons made in the following treatment, as, for example, between right and left, or as between one age and another, the results obtained within the same 5 mm. of the scale are compared.

*Extreme Limit of Variation.*

The total reductions in the mean deviations between ages 6 and 16 are as follows: Boys, right, down, .26 mm.; boys, right, up, .24 mm.; girls, right, down, .21 mm.; girls, right, up, .21 mm.; boys, left, down, .33 mm.; boys, left, up, .34 mm.; girls, left, down, .33 mm.; girls, left, up, .28 mm. In each case the results are given in terms of 2x, where x is the mean deviation in one direction from the straight line which bisects the angle a.

The most obvious fact which appears is the great gain made between ages 6 and 8. This can be shown by placing side by side the gain in those years and the total gain from 6 to 16.

TABLE XXII

| | BOYS | | | | GIRLS | | | |
|---|---|---|---|---|---|---|---|---|
| | R. Down | R. Up | L. Down | L. Up | R. Down | R. Up | L. Down | L. Up |
| | mm. | mm. | mm. | mm. | mm. | mm. | mm. | mm. |
| Reduction of mean deviation between 6–8 . . . . . | .128 | .096 | .098 | .096 | .090 | .125 | .095 | .115 |
| Reduction of mean deviation between 6–16 . . . . . | .26 | .24 | .33 | .34 | .21 | .21 | .33 | .28 |

Turning to the records from 12 to 16, I am unable to draw any conclusion as to the effect of the physiological changes in that period upon the degree of precision, except that the effect is too small to appear clearly from the amount of the data possessed.

[The right hand is, on the average, superior in precision to the left at all ages (in right-handed children), but the amount of the superiority decreases markedly with age. The figures given by Bryan are as follows:]

*Average superiority of R. over L. in terms of x mm.*

| AGE | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Av. x, | .122 | .12 | .114 | .101 | .097 | .09 | .087 | .06 | .07 | .038 | .025 |

[Note. — The figures .122, .12, etc., represent the amount by which the inaccuracy of the left hand's movements was greater than that of the right hand's.]

[Another set of experiments on precision were made with the following apparatus:]

Paste smoothly upon a slab of plate glass a 1 sq. cm. piece of platinum foil perforated by a circular hole 1 mm. in radius and connected with one pole of a small battery. To the other pole of the battery attach by a fine flexible wire a steel needle, set in a wooden penholder. Required to hold the point of the needle at a fixed distance perpendicularly above the centre of the hole, and at command to tap the glass within the hole. A telegraph sounder gives the signal if contact is made.

* * * * * * * *

## SCHOOL TESTS ON PRECISION

*Probing Movement.*

With few exceptions the children tested by the foregoing methods were tested also for precision in the movement just described. Five trials were made with the right hand and five with the left. A board was held in position 6 mm. above the apparatus; the penholder was each time lifted until its upper end touched this board. It cannot be guaranteed that the pen will always be held in a perfect perpendicular, and accordingly the minimum distance to be moved, 6 mm., was sometimes slightly increased. If we assume what is quite certain, that in no case the pen was permitted to slant so much as thirty degrees, the maximum distance moved was always less than 8 mm.

The forearm was allowed to rest upon the table. The pen was directed mainly by the movement of the wrist, in a slight degree sometimes by movement of the elbow. Concrete directions by word and example,

as in the writing movement test, were given. No record was taken unless and until the child gave satisfactory evidence that the task required was understood. The results were classified according to the age and sex of the pupil and according to the hand used.

* * * The probability of tapping within the hole without touching the platinum was determined for each set into which the results were classified. From this probability and the known value of x, the radius of the hole, were determined the values of h in each case, and the radii of circles within which in the several cases two-thirds of the results would probably fall.

[That is, Mr. Bryan calculated from the number of times the children hit the hole, 1 mm. in radius, the exact radius that a circle would have to be in order that the children concerned would hit inside it about two out of every three times they tried. or, to be exact, 68 times out of every 100 they tried. The bigger the radius required the greater the inaccuracy.]

Table XXV gives these results and Chart V shows graphically the same facts.

[Chart V is here omitted.]

TABLE XXV

*Table showing in mm. the radii of circles within which 68.3% cases would fall*

| AGE. YEARS | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Boys, Right | 1.10 | 0.97 | 0.87 | 0.80 | 0.67 | 0.65 | 0.53 | 0.58 | 0.60 | 0.42 | 0.44 |
| Left | 2.09 | 1.69 | 1.50 | 1.05 | 1.01 | 0.90 | 0.86 | 0.87 | 0.96 | 0.79 | 0.94 |
| Girls, Right | 0.91 | 1.01 | 0.85 | 0.86 | 0.69 | 0.69 | 0.59 | 0.61 | 0.53 | 0.49 | 0.40 |
| Left | 1.84 | 1.24 | 1.15 | 1.27 | 1.05 | 1.02 | 0.83 | 0.97 | 0.74 | 0.82 | 0.77 |

*Resumé of Results from Precision Experiments*

1. In normal individuals, the precision of voluntary movement is subject to much greater variation than is the maximum rate of movement. This test will probably distinguish pathological from normal deviations surely, only when the ataxia exists in a considerable degree, or when many tests are made.

2. The absolute size of deviations from the movement attempted decreases much more rapidly in the two or three years following the age of six than later. This is particularly true in the case of the right hand.

3. In right-handed persons, the right hand is superior to the left in precision, in about 80% of individual cases. Between ages 6 and 16, the deviations of left-hand movements decrease by a greater absolute amount than do those of right-hand movements. This is true for boys and for

girls, in both directions of the familiar writing movement, and in the unfamiliar probing movement.

4. The errors are, of course, greater with the unfamiliar probing movement under the conditions described than with the familiar writing movement. The decrease of the absolute size of the mean deviations is also greater.

5. There is little mean difference in precision between boys and girls. These results indicate a slight superiority in favor of boys.

## A PRELIMINARY STUDY OF MOTOR ABILITY

By JOHN A. HANCOCK, Fellow in Pedagogy, Clark University

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The enormous difference in ability between the child and the adult, both physically and mentally, is fully realized by few. While it is commonplace to say that there is such a difference, yet the practice of the school makes comparatively little allowance for it. Pedagogy is based on the psychology of the adult mind, and the conditions of school-room work are generally adapted to the adult. It is obvious that instruction and discipline should be adjusted to the mental and physical stages of development of children; and that we need to know just what the ability of children of each age is in order to plan a fitting course of education.

The following investigation was begun for the purpose of finding what movements children can best make; to learn something more definite of the relative ability of children and adults, and of the relation between development and decline of motor ability; and also in the hope of finding simple tests for incipient nervous diseases.

### I

In directing the work of a body of teachers in the field of child study, the writer compiled the following circular. It served in his own investigations, of which this paper is a preliminary report:

#### THE MOTOR ABILITY OF CHILDREN

Very little study has been made of the motor ability of children. It is probable that we could teach many of the subjects of the common schools better if we knew just what movements children can make. Kindergarten training would also be placed on a more satisfactory basis.

Preyer has shown that children in learning to talk have the same difficulties as people who have diseases of speech.

Peculiar movements, such as dragging the feet, trembling of the hands or head in adults, are symptoms of certain diseases of the muscles and nerves. It will be of interest to determine whether in the normal growth of children such movements do not also appear.

It has been suggested that certain nervous diseases of children begin while they are yet able to attend school, and that by simple tests, cases of such diseases may be determined during their school stage.

To aid in solving these problems the following tests have been gathered from various sources, and are now offered for trial and criticism.

In testing pupils take two or three of them at a time, before or after school, noting which time. Record age, sex and nationality. Use but one syllabus at a time — the other some days later. If it should seem best to you, omit any one of the tests. If the pupil shows signs of fatigue, do not continue testing him. Give absolutely no help other than indicated in the directions, for results obtained can not show in any way the value of your teaching. The most insignificant looking paper is often, to the expert, the most valuable; so make no effort to make your returns "show up well." Number your results to correspond with the tests.

*First Series*

1. [1]Ask the child to stand with feet close together and hands at sides. Is there any swaying of the body? Try same with eyes closed. What difference?

2. Have him walk across the room backwards with eyes closed. (Keep near him to prevent falling.) Is there any dragging of either foot, walking with feet wide apart, or turning to right or left?

3. Have him try to sit still a half minute exactly. Note all the movements he makes in the effort. Does he hold his breath?

4. Ask him to close his eyes and hold his hands out horizontally with the fingers spread. Is there tremor or twitching of the fingers? Which ones and in what directions? Is it slight or distinct?

5. Hold your hands above your head out of sight and with palms front. Ask him to do the same. Does he raise them to the same height? Hold them symmetrically? Are the fingers or thumbs spread apart on either hand? Which? Which hand sinks first on a half-minute's trial? Hold up your own hands but a moment.

6. Place him ten feet away. Toss back and forth ten times a ball as large as a tennis ball. How and where does he throw it? How many times does he catch it?

7. Ask the boys to lie down on their backs, if they are willing. How do they get up? Have they difficulty?

8. Ask for the pronunciation of these letters and words and note errors: r, l, s, t, k, d, f, n, v, y, go, which, thin, the, long, show.

9. What signs of mental fatigue have you noticed in him in school work? Has he made any involuntary movements during these tests?

10. Please add any comments or suggestions that may occur to you.

[1] The swaying may be charted exactly and easily; if desired, directions will be given.

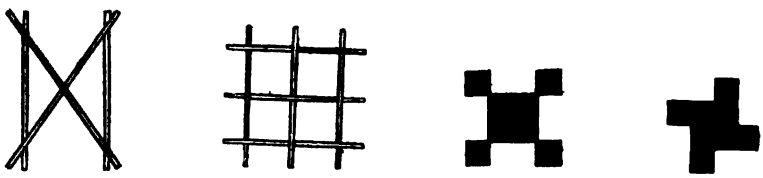
*Second Series*

1. Does the child dress himself? Button his clothing, and fasten hooks and eyes?

2. Can he tie the ends of a string together? In what kind of a knot?

3. Can he thread a needle? How small a one? In which hand does he hold it?

4. Can he interlace slats? Interlace four and six before him? See patterns one and two. Does he even copy the pattern?



1 2 3 4

5. Can he wind thread on a spool? How does he do it?

6. Can he spin a top made of half a spool or button mold? Can he snap a marble?

7. Can he hop on each foot? Stand on tip-toes or heels? Touch his knees or shoes while standing?

8. Place before him pattern number three; give him squares of paper or square blocks; ask him to imitate it. Then show him number four. Does he shift the outer blocks of number three to make the other figure, or does he build anew from the beginning? The patterns may be shown him drawn full size on paper, or made of the blocks. If he fails, divide each pattern vertically in the middle; try him and note results.

9. Count and beat time, double, treble and quadruple. Can he do it? Rapidly?

10. Does he swing his arms or sway his body when walking? Can he march, keeping step as you count time or play for him? Can he run and keep time? Does he, when marching, move the head, eyes, mouth or tongue?

11. Pat the top of your head and at the same time move the other hand in a circle on the breast. Can he imitate you?

12. Rest your forearms on the table, the hands in an easy position with the fingers curved, and the lower parts of the palms and the tips of the fingers touching the surface of the table. Begin tapping, letting the movements proceed rapidly from the little fingers to the thumbs. Ask him to imitate you. Notice the movements he actually makes. Are they with the hand and arm moving together from the elbow; the whole hand moving from the wrist; all of the fingers moving in unison from the knuckles; or with index finger alternating with the other three? Reverse the tapping, beginning with the thumbs. Can he imitate you any better? Just what does he do?

13. Can he drive a nail, or hit it squarely after several trials when started for him?

14. Can he roll a hoop? Skate? Turn a somersault or walk on his hands? (The boy, of course.)

15. What movements seem to you to be most difficult for children to learn?

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Sluys, *Manual Training in Elementary Schools for Boys.* Industrial Educational Association, New York.

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The small numbers in the text refer to the following:

1. Dana, *Text-book of Nervous Diseases,* p. 38.

2. Bullard and Brackett, *Boston Medical and Surgical Journal,* Vol. II of 1888, pp. 600–603. Also Vol. I, p. 136.

3. Hinsdale, "The Station of Man." *American Medical Journal,* Vol. XCIII, pp. 478–485.

4. Jastrow, *American Journal of Psychology,* Vol. IV.

5. Bullard and Brackett, *Boston Medical and Surgical Journal,* Vol. II of 1888, p. 598.

6. Bryan, "On the Development of Voluntary Motor Ability." *American Journal of Psychology,* Vol. V, No. 2.

7. Sturgis, *Report of Congress of Hygiene and Demography.* London. Part IV, pp. 20–27.

One hundred and ten of the children tested are in the public schools of Worcester, fifteen are in a Catholic orphanage, and the remainder in a parochial school. The ages of the children are five, six, and seven. All were in the first year of school work. The children in the orphanage, though mainly from the homes of the very poor, were well cared for. One of the public schools uses a modification of the kindergarten work in connection with the usual primary work. No rejection of any child was made except when over seven years of age.

Previous to beginning work, the school was visited and an effort was made to become acquainted with the children. The children were told that no one need be tested unless willing. In three cases children refused, but later came voluntarily and asked to be tested.

At the outset the work was found to be fatiguing to the children. It was accordingly divided into three parts and the round of the school taken with each.

The experiments had in large part to be made in hallways, but this did not seem to make any difference. City children, like their elders, pass and repass people many times each day and pay no attention to them. Rarely was head or eye turned to chance passers.

Two children were sent out at a time. Generally one or more teachers were present as well. At one school also, a boy was present "who, for being good and working hard," was permitted to come out and see the "machine"; and twice a girl from a higher grade, who came down stairs "with the nose-bleed," spent two hours in "helping."

In the effort to train the intellect of the child, considerable quiet is demanded of him. It is one of the "faults" of children, in the minds of many teachers and parents, that they do not keep as quiet as the adult. The quiet child who sits through the sermon, or who sits still when callers are present, and who does not tear or soil its clothing, is liked and given the reputation of being good.

With the purpose of studying the ability of children to keep quiet, the first test was devised. The apparatus used is known as the ataxiagraph. (1) It consists of an upright support, to which is attached an adjustable arm about two feet long. At its extremity is attached a large cork. A small glass tube passes through it. Within the tube, working up and down, is a glass rod about six inches long, and drawn to a point at its lower end. On the upper end is attached [a] small cork to keep the rod from falling through. A piece of smoked paper is pasted to a glass plate, four by five inches, at the edges. The plate is then ready to attach to a cap. This should be a flat-topped one with a rubber band, under which the plate can be secured at one edge. After the tracing is taken, the plate is removed, the paper cut off, and given a bath in shellac and dried.

Since it appeared that the position taken by the subject required a coördination of a large number of the largest muscles of the body, this test would show something of the control of them. The child was asked to stand with feet close together and hands at sides, to keep his attention on a distant object, and to try to stand still for a minute. After this was done he had half a minute or more of rest, when the test was repeated with eyes closed. Specimen tracings for men and children under similar conditions are given.

No device was available for measuring the amount of movement exactly. It is in almost every case very much greater for children than for men. The rectangles which would just contain these tracings in the anterio-posterior and lateral directions were measured. In thirty cases the tracings were repeated at a later date without material difference in the rectangles, and with fully as miscellaneous movement.

Bullard and Brackett (²) studied the swayings of 150 men who were between the ages of twenty and thirty. They were competing in a physical examination and were all in good health. They were tested for a half minute only. As this fact was not learned till the tests on the children were well under way, a number of tests were made on men for a whole minute, but without material variation from the averages of the 150. These averages found by Bullard and Brackett were, with eyes closed, 3.764 cm. in the anterio-posterior direction by 1.951 cm. laterally; with eyes open, 3.475 cm. by 1.963 cm. Hinsdale found (⁸) that normally the anterio-posterior measurement was one-third to one and one-half inches, and that swaying generally increased when eyes were closed. His tests were for a minute. He had but twelve subjects — young men in good health. The average measurement of these men was 2.55 cm. by 2.1 cm.

He found ataxic cases to sway from 5.7 cm. to 7.0 cm. in anterio-posterior direction by 6.35 cm. to 8.2 cm. laterally.

He measured, also, ten cases of chorea. The anterio-posterior average was 1.35 in. (5.5 cm.); the lateral average, 1.45 in. (3.7 cm.).

The averages in my own tests are as follows:

| | EYES OPEN | EYES CLOSED |
|---|---|---|
| 35 boys, 5 years old, | 5.8000 cm. by 5.2228 cm.; | 6.6810 cm. by 5.7675 cm. |
| 22 girls, 5 " " | 5.7773 " " 4.9500 " | 5.5400 " " 5.0954 " |
| 47 boys, 6 " " | 5.1148 " " 4.2660 " | 5.6957 " " 5.1637 " |
| 18 girls, 6 " " | 5.0611 " " 3.7277 " | 5.6000 " " 4.3333 " |
| 23 boys, 7 " " | 4.9608 " " 4.2434 " | 6.0086 " " 5.4521 " |
| 13 girls, 7 " " | 3.9538 " " 3.2769 " | 4.8230 " " 3.7615 " |

One hundred and ten were steadier with the eyes open than with them shut; forty-eight, with eyes closed; in two cases there was no difference. The child being shorter, would sway less than a man, were other conditions the same. In point of fact there is a significant difference in the other direction.

With eyes open there is an increase of control in each year. The girls are steadier than the boys. Both of these facts were to be expected,

since girls mature earlier than boys, yet if the number of subjects was larger, and equal for each sex, a different result might be found.

During these tests frequent twitchings of the fingers were observed in a large majority. Out of this and the many other involuntary movements came the suggestion to try the steadiness of shoulder and finger, and so to get some comparative results for control of large and small muscles.

The instrument named by Jastrow the automatograph was used. It is described by him as follows: (4) "There is first a piece of plate glass, fifteen inches square, resting on a stout wooden frame; this frame is mounted on three adjustable brass legs, raising it an inch or so from the table. By means of the screw adjustment of the legs, the plate glass is brought into exact level. Three brass balls, which must be very perfectly turned and polished spheres, about three-fourths of an inch in diameter, are placed in the form of a triangle upon the plate; upon these balls rests a very light wooden frame. The recording of the movement is equally simple." To the light frame is attached a slender rod about six inches long, bearing at its end a device the same as used to mark the movement in the ataxiagraph. A screen is used to prevent the subject from seeing the record.

No tests so far as known having been made for this particular purpose, trials were first made on twenty-five of the Clark University men. The subject was seated with back supported, the hand and forearm resting with palms downward on the instrument, the elbow slightly flexed, in order that no strain might be brought on the muscles controlling it. The position admits of free lateral movement of the shoulder and of very little in a direction perpendicular to the body. The subject was asked to hold his arm still for a minute. He was told to do this as he looked at his hand. After an interval of a half-minute or more for rest, the test was repeated with the eyes closed. The averages for both men and children are as follows:

| | EYES OPEN | | EYES CLOSED | |
|---|---|---|---|---|
| | Perpendicular Movement | Lateral Movement | Perpendicular Movement | Lateral Movement |
| 25 men, | .242 cm. | by .752 cm.; | .156 cm. | by 1.460 cm. |
| 18 boys, 5 years old, | .816 " | " 3.400 " | 1.027 " | " 4.916 " |
| 15 girls, 5 " " | .833 " | " 3.940 " | .780 " | " 4.706 " |
| 34 boys, 6 " " | 1.191 " | " 4.258 " | .805 " | " 5.058 " |
| 12 girls, 6 " " | .433 " | " 3.883 " | 1.825 " | " 4.166 " |
| 14 boys, 7 " " | .500 " | " 3.750 " | .428 " | " 5.207 " |
| 10 girls, 7 " " | .410 " | " 3.580 " | .480 " | " 3.550 " |

The relative difference in the control of child and man here is greater. The rectangles are smaller because the levers are shorter, for one thing. The measurements in the case of the children are unsatisfactory so far as the perpendicular movement is concerned. The difficulty of keeping the children from moving the body, although it was well supported, was so great that this measurement is of little value as a test of control of shoulder movement. The breathing, also, influenced it more

than it did the lateral movement. Recesses in all the schools were so short that the chances for active play unsettling the steadiness of the muscles were very slight.

Bullard and Brackett (*) used in testing the control of the entire arm an instrument known as the tremograph. It is described by them as follows: "It consists essentially of a long, light wooden rod, which runs through a closely fitting brass cylinder so hung in a vertical compass joint on the top of a firm upright as to permit of movement both vertically and horizontally in all directions. One end of the rod is furnished with a thimble, or some other contrivance, for holding the finger, while to the other is attached a Pfluger's pen. Various weights are attached to the rod in order perfectly to balance it. The upright, made of brass, is placed in the centre of a rectangular wooden platform with low grooved sides, into which it fits closely. At one end of this platform is a transverse groove. This groove serves to hold the glass plate, over which the paper for the tracings is stretched, while the board supports it behind."

The subjects sat with back supported, the forearm and hand resting on the table, palm of hand downward with tip of finger resting in the thimble, the thumb and other fingers so placed that no strain or effort should be felt in them. Early in the work, the fact developed that children could not hold their attention for a whole minute on the index finger as requested. No amount of persuasion availed. After a half-minute, and sometimes before, all control of the finger seemed lost, hence the finger tests were all made for a half-minute on both men and children. Control of the muscles and attention seem to me to be too closely associated in young children to permit study of either separately.

The instrument multiplies the movement four times; the results are reduced accordingly. The same university men gave tracings for this test. The following are the results:

| | EYES OPEN | | EYES CLOSED | |
|---|---|---|---|---|
| | Vertical Movement | Lateral Movement | Vertical Movement | Lateral Movement |
| The men, | .0975 cm. | by .0911 cm.; | .085 cm. | by .110 cm. |
| 17 boys of 5, | .985 " | " .532 " | .794 " | " .680 " |
| 14 girls of 5, | .580 " | " .337 " | .714 " | " .453 " |
| 32 boys of 6, | .396 " | " .378 " | .689 " | " .543 " |
| 12 girls of 6, | .394 " | " .319 " | .535 " | " .395 " |
| 13 boys of 7, | .419 " | " .282 " | .693 " | " .442 " |
| 8 girls of 7, | .300 " | " .356 " | .312 " | " .365 " |

The same general relations hold in this table as in the others.

Reckoned in terms of the nearest centimeter, the anterio-posterior swaying of men and children are as follows:

| CM. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 men . . . . . | 1 | 20 | 37 | 48 | 24 | 11 | 9 | 6 | 2 | 1 | 0 |
| Children . . . . . | 0 | 16 | 1 | 11 | 31 | 45 | 35 | 13 | 13 | 7 | 2 |

The following will show the ranges in lateral control for the shoulder:

| CM. | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 | 5.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 men | 0 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 5-yr.-old boys | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 7 | 4 | 1 | 6 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |

The chart shows the ranges for the finger.

[This chart is here omitted. — E. L. T.]

Bryan (*) has shown that the rate of tapping for the child of sixteen is about five times (note) as great as for one of six, and that hand power is later than arm power in developing, but gains and eventually surpasses the arm power. Taking the rectangles of the standing and finger tests, and the lateral measurements of the shoulder test, the ratio of control between a man and a five-year-old child in the swaying test is as 1 to 4.1; for the shoulder, 1 to 4.5; for the finger, 1 to 5.8. While these results may not stand with more extended research, the truth evidently lies in the direction they indicate; and, in my opinion, the motor control in man is from three to six times greater than that of children in the first year of school life.

The order of control is from fundamental to accessory, and is evidently in harmony with the theory of physiological development.

[Note. — This is presumably a typographical error. The rate in question is about *twice* as great. — E. L. T.]

## II

The following results are from simple and general tests, and throw some light on the motor ability of children to make complex coördinations, both of larger muscles and of smaller ones.

A pattern found in most of the kindergarten guides consists of four slats interlaced. This was taken for a test, using slats eight inches long and one-half an inch wide. Four were taken and interlaced before the children, and left so for them to see; four others were then given to each child, and the children were asked to interlace them. The slats were interlaced a second or even a third time before the children, yet but one child — a girl of six — succeeded; nine copied the figure, the remaining fifty failed wholly. There was not opportunity to test more.

Test number twelve of the second series gave significant results; 162 children were tested with this, none of whom succeeded in reversing the movement; five succeeded somewhat slowly in tapping correctly with both hands; four were successful with the right hand only, and three with the left; fifty tapped with the whole hand, using a wrist motion;

nine with the whole hand, using an elbow motion; five with the whole hand, with both an elbow and a wrist motion; forty-nine alternated the index finger with the other three; seven of these, however, did this with one hand only, the movement of the other being with all the fingers moving together from the knuckles; twenty-five gave irregular movements indefinite and uncertain, but in many instances approaching success; in twelve cases the movement was from the knuckles, all of the fingers moving together.

I am not concerned at present with the effect of training on the ability of children to make these movements, but rather with the problem, What is the period of the development of function in the nerve centres controlling the finer muscles concerned in delicate coördinations? Evidently for these children it is only beginning.

Fifty-six boys were asked to thread a large needle; fifty succeeded, but often only after two or three efforts; six failed, though given extra large needles and more time. It was evidently new to most of them. After the first trial there was in many cases apparent a feeling of nervousness.

Twenty-two out of sixty-three children failed in the effort to tie the ends of a two-foot string together. Those who succeeded tied, in every instance except four, the ends by placing them side by side. This is the simplest form in which it could be done.

In the tests for the coördination of the larger muscles, far less difficulty was experienced. The eleventh test of the second series has often been tried by older people, and in some places by children. It was new to the children reported on here. The novelty first amused them, yet all but three asked made an effort to get the movement. They were first asked to make one hand move in a circle on the breast; after this was started, they were asked to place the other hand on top of the head and pat with it. In forty-five cases the result was either patting with both hands or moving them both in a circle. In the other ninety-seven cases there were first unsuccessful movements, often patting with both hands, or moving both in a circle, or an alternating of these, but a considerable degree of success followed in each case.

One hundred and sixty were shown how to beat time. Arm movements were used. Practically all could beat double time freely. Treble and quadruple were more difficult, but by going slowly it was done by all but fifteen. Not more than two minutes' time was taken with each test; and it seems reasonable to suppose that, with ten or fifteen minutes' careful training, all could succeed.

Details of individual cases are of interest. As showing something of the range, these three are given:

M. is a girl of six years. She has now had about eight months' schooling, all told. Her teacher speaks of her as one of the brightest pupils. The rectangles for the swaying test were 3 cm. by 4.1 cm. and 4.4 cm. by 2.9 cm. These are among the smallest. The lateral movements for the shoulder were 3.8 cm. and 3.1 cm. These were not so small as many others. For the finger the rectangles reduced were .075 cm. by

.05 cm. and .15 cm. by .05 cm. Here, again, she is among the best. She could walk normally with the eyes closed. One finger trembled when she was tested for tremor, but she was quite free from all trace of tendency to chorea. In the tapping test she used a wrist movement for the whole hand, yet she was the only child who succeeded in interlacing four slats. She had no difficulty with any of the tests for the use or coördination of the larger muscles. Her general appearance is that of a healthy, intelligent child. B., a boy of five years, is one of the interesting cases at the other extreme from M. He is one of his teacher's "third best; bright as could be expected from *him;* not very good in his lessons, but *not* a bad boy." His results in the first test were 5 cm. by 2.4 cm. and 8.5 cm. by 4 cm. He so thoroughly lost his balance with eyes closed that he was caught to save a fall. The lateral measurements for the shoulder were 3.3 cm. and 2.2 cm. Here he did his best. The rectangles for the finger were, reduced, .35 cm. by .075 cm. and 1.2 cm. by 1.4 cm. He seems some stronger and brighter than his twin brother, yet the brother's measurements were some better. He shows decided tendencies to chorea, and is generally somewhat nervous. He cannot speak distinctly, failing on r, l, f, th, and ng. He failed wholly on the tests for finer movements, while in those for the larger movements he succeeded only in beating time. A., B.'s sister, is six years old, and is one of her teacher's "second best; she tries hard, but does not succeed so well as some." In the first test her measurements were 4 cm. by 1.8 cm. and 8.5 cm. by 3.5 cm. The lateral movements for the shoulder were 1.2 cm. and 5.2 cm. For the finger they were, reduced, .35 cm. by .5 cm. and .525 cm. by .25 cm. She also has strong tendencies to chorea. In the tests for the control of the finer movements, she was able to differentiate the control of the index finger; she could beat double time only, and failed wholly on test number eleven of the second series. She and her brother are Irish, plain looking, though not stupid, yet evidently not amongst the teacher's best.

The results thus far seem to justify the following inferences, though more extended research may change or modify them.

Children early learn to make movements involving large muscles. They succeed easily in large movements of some degree of complexity. The order of development of control is evidently: body, shoulder, arm, forearm and hand. In the hand control the index finger differentiates before that of the others.

Fine and complicated movements are made with difficulty.

Efforts to keep quiet produce strong symptoms of nervous irritation. Movement is inhibited only in part, and awkward swayings and twitchings result.

Children have far less control of their muscles than adults, as is shown in each of the tables.

Generally, the girl at the same age is steadier than the boy.

Children in normal, healthy growth show a lack of coördination and control paralleled only by ataxic, choreic and paralytic patients.

In support of this, there were found thirty-eight, out of one hundred and fifty, dragging the feet or walking with them wide apart when eyes

were closed. The swayings of a very large number equal or exceed that of the ataxic patient. With test number four of the first series, in fifty cases there were twitchings and tremor in both directions. In twenty-six cases there were twitchings forward and backward only, and in twenty-seven there were twitchings sideways only. Perhaps the twitchings were noticed more in the left hand, and there in the ring finger. Considerable care and practice are necessary to see and determine these. If this test is of value, apparatus for measuring and recording should be devised and used.

Sturgis's test for choreic tendencies showed that but half of one hundred and fifty children tested were free from them. To show the importance of a knowledge of chorea and the value which Sturgis places on this test, I give here his own statement: (1)

"1. Movement disorder is the product and the index of mental disturbances, and may be known by nice observations of the higher muscles (the face and hands) before it has reached the stage to which the term St. Vitus' dance (or chorea) properly applies.

"2. When the school child (and especially girls between seven and twelve or thereabouts) alters in temper, works less well, less willingly than usual, gets untidy or slovenly — in a word, degenerates mentally and bodily, inquire of the mother as to home conduct and temper. Ask particularly how the child sleeps, and whether she complains of headache or limbache, and whether her food is sufficient.

"3. Amongst the incidents of school life apt to be injurious, in the way we are considering, there stand out prominently examinations, moving into a higher class, sums (too difficult or ill explained), and punishment or admonition before fellows.

"4. The best index of muscular infirmity tending to St. Vitus' dance is the hand. Face mobility may be mere nervousness, the tongue may be tremulous by nature. The hand test is infallible, and may be thus applied:

"Bid the child hold up both hands open, with extended arms, the palms towards you. If that is done steadily, both hands upright, and both alike, no finger or hand quivering, no falling back of either hand, nothing to choose between the positions of the two, then the child has not nor is it near (either before or after) St. Vitus' dance. You may confirm this test by another. Let the child place the open hands upon yours, palm to palm. Look then at the backs of the child's hands, observe whether fingers or thumbs (especially the latter) repose without tremor and without restraint."

In the gradual acquisition of control of its muscles the child needs to be carefully guarded from inconsiderate treatment. He should, if chorea seems at all imminent, be taken out of school, freed from responsibility, and given for some weeks a quiet out-of-door life, with plenty of nourishing food and as much sleep as possible.

From these studies one gets a fairly accurate though complex and incomplete account of the changes in the motor ability of children, changes which progress with age toward greater precision and more perfect control.

What, now, are the general causes at work in producing those changes? As usual, we have to choose among (1) inner development that comes as a consequence of growth, as a gift of nature, (2) learning or experience in making coördinations, and (3) general changes in intelligence that make pupils understand better what they are asked to do and try harder to do it. As elsewhere, the practical consequences of the acceptance of any one of these theories about the development of motor ability are tremendous.

It may be said at the start that all three factors are at work, and that the question is to assign the proper share to each.

We shall get along better if we restate the question by dividing the fact of coördination into two facts. Let us speak of the anatomical concord of movements and the psychological association of movements. By the anatomical concord of movements let us mean the contemporaneities and sequences of movements so far as determined by the structure of the nervous system due to its inner growth, and by the psychological association of movements let us mean those contemporaneities and sequences which are due to learning, practice. Instances of the former would be the simultaneous contractions and relaxations of the sets of muscles moving the two eyes by which infants at an early age move both eyes together in following an object, the simultaneous contractions of the muscles which hold the forefinger straight and extend the arm, the successive contractions by which the legs are moved in walking or the vocal cords, mouth, etc., moved in crying or babbling "ma." Instances of the latter would be the contractions causing us to hold the pen and also move it in writing, to say, "Ma — ma — please — give," in order. The second sort evidently develops out of the first sort. Unless there were given structures in the nervous system causing such movements as produced the babble of infants, we could not, by learning to put different modifications of these movements together, have the psychological associations causing articulate speech. And until these concords are given the associations must wait.

If the concords for grasping appeared first in the tenth year,

instead of the first month, children could not form the psychological associations of using knife, fork and spoon until then. But once given certain elementary combinations of coördinations, and we go on smoothly to recombine them, to add to and subtract from them, and to connect them with others.

There is one further matter to make clear, if possible, though it does not admit of full comprehension by those unacquainted with the finer anatomy of the brain. Just as cell structures grow and develop connections which are manifested in the anatomical concords we have mentioned, so cell structures and connections may develop which are not openly manifested in any coördinated movements, but *which permit such movements in case circumstances coöperate.* For example, it would seem as if the movements of the vocal chords, etc., involved in the imitation by hunters of the calls of wild animals were not necessarily openly manifested. Many people who could make them never do. Those who do make them make them years perhaps after the possibility of making them was first present. We cannot be quite sure of this, but it seems likely that the inner growth of the nervous system brings about not only actual movements which we modify by learning, but also possibilities of movements which we may or may not realize. In the case of these as well, provided they exist, we should have to wait until inner growth gave the possibility before we could have the actual performance.

The practical import is simple enough. (1) It is folly to try to teach children to make any coördinated movements for which the necessary anatomical concords, either openly manifest or not, are not yet developed. It is as foolish as to try to teach the six-year-old to look over a fence six feet high. (2) It is conceivable that there is an optimum time to teach different classes of movements, a time when the anatomical concords on which they are based are readiest to be modified with least likelihood of injury to nervous health.

If we knew just the times when the different anatomical concords were developed, and on just which of them the different movements used in reading, writing, drawing, manual training, sewing, etc., depended, we could so plan our courses of study as to take the tide of nervous growth at its full. We could avoid premature efforts that would be bound to end in failure. We would save children from learning with difficulty and danger

things they might, earlier or later, learn with ease and profit. We do not know the times when the different concords are developed, nor even their order.

This ignorance results in all sorts of opinions and hypotheses. The immaturity of the nervous system is used by some as an argument against the introduction of reading or writing before the age of ten, against many of the kindergarten occupations, against all fine manual work in the three or four lowest grades. We find physicians protesting that the schools everywhere demand of the nervous mechanisms of children fine movements, which they either cannot do at all or can do only at the expense of health. We find in some cases these same physicians advocating fine finger movements as remedial treatment for children whose nervous mechanisms don't work well. We find intelligent teachers who have watched the results of fine movements on the children who were forced to make them, unaware of any signs of evil results.

One notable theory of the order of the development of these anatomical concords is that those concerned with the fundamental or trunk muscles come first, and those concerned with the muscles of the extremities later. Of these latter those concerned with the muscles nearest the trunk precede.

Most of the writers about coördinated action as a result of inner growth are very free with general statements and very chary of any definite dates and still more so of any proof that their dates are correct. For instance, no one has proved that any of the nervous basis necessary for the associations involved in the reading, writing, drawing, cutting, pasting, measuring, modelling, sewing, etc., commonly taught in schools is delayed in appearance till after the fifth birthday. And it is hard to explain the infant prodigies who play the piano or violin at four or five, who learn to read Latin before they are seven, who do gymnastic and juggling feats, etc., if we agree that fine movements of the hands, eyes, etc., develop late. As to the general law that movements develop in the order of their grossness, the coarser ones first, it is completely false as a complete account. Darwin pointed out that one of the first coördinated movements to develop was one of the finest, namely, the curling of the toes and grasping by the fingers. These movements of the extremities come long before many movements of the trunk, shoulder and thighs.

There are certain lines of evidence in the articles quoted which emphasize the importance of inner growth as a cause of the improvement with age. Bryan, it will be remembered, found that in both rapidity and precision of movement the left side of the body improved as much as the right. Now this would seem to show that training could have little to do with the improvement, since the right side would be trained in the movements tested much more than the left. Oddly enough, in the experiment on the ability to draw a straight line, the case where practice would seem to be of the most importance, the left hand improves more with age than the right. This equal progress of both sides is perhaps the strongest argument for belief in the growth of motor control as the result of general physical growth, and it should have much force. At the same time we must remember that any increase in general intelligence due to training would improve the records of left as well as right. Moreover, there is a tendency for any one making a simple movement with his right arm to contract the corresponding muscles in the left arm. We may thus get unconscious practice of the left arm.

There is also a set of facts among Bryan's results which, if we regard the progress of the left side of the body as evidence that training is an unimportant factor, supports the theory that the order of development of motor coördinations is from the trunk muscles toward those of the extremities. Bryan found that from 6 to 16 the finger improved most, the wrist next, the elbow next, and the shoulder least. The percentages of gain in rapidity for boys I calculate as:

| | | | |
|---|---|---|---|
| Right | F | 73 | per cent |
| | W | 56 | " " |
| | E | 48 | " " |
| | S | 45 | " " |
| Left | F | 77 | " " |
| | W | 67 | " " |
| | E | 50 | " " |
| | S | 46 | " " |

Excluding training as a factor, it would seem that the finer movements reached the same relative level of control later as the large movements. However, we should note that there was no very obvious early "ripening" of the shoulder and elbow movements. They keep improving right up to 16 years, just as do the finger movements, though not so fast.

There are, finally, some facts in Bryan's study which may be taken as witnesses against the importance of inner growth as a factor. If the control of, say finger movements, comes with mere maturity, we should expect the increases in rapidity of tapping, accuracy of drawing a line and accuracy in the probing movement to follow the same general progress. They should have the same accelerations or retardations in rate, the same general character in all respects, for they would, by hypothesis, be due to the same causes. They do not. The peculiar pre-pubertal phenomena in the case of the rapidity of movement do not appear elsewhere. The extremely rapid rate of improvement from 6 to 8 years in the case of the straight-line movement does not appear elsewhere.

If we know little about the dates of appearance of the different nervous structures which make the psychological associations possible, we know still less about the degree to which they are perfect at the start or the extent to which mere growth perfects them or the way in which it does it.

The best practical attitude for the teacher of children 6 to 12 to take would seem to be to find out, by trying, the most economical time to teach the movements he wished the children to know and to make sure, again by trying, that they do not hurt the children's health. Whether they will or not cannot be told beforehand by any theory about the development of the brain by virtue of its inner growth, but only by observing directly the signs of brain-exhaustion.

What movements a child can profitably learn depends not only on what anatomical concords are present, but also on what psychological associations have been built up. If we wish to teach a child to carve an Indian out of wood, we require not only that he shall have a nervous mechanism allowing him to grasp, hold, move his hands and fingers freely, but also that he shall have learned how to hold the knife, how to cut so as to take off a small or large piece at will, how to cut in an eighth or a quarter of an inch at will, etc. The influence of previous experience is as potent in the case of making movements as it is in the case of thinking thoughts. If the child of eight can learn to write more quickly than the child of five, it is in great part due to the fact that in the three years he has had experience of the finger and wrist movements involved, in his use of knife and fork and spoon and

pencil and toys, and so on. We can never estimate how much inner growth does for him until we learn how much experience does for him and deduct that much from his total advance.

Increase in motor ability, we said, was also dependent on general changes in intelligence, that make pupils understand better what they are asked to do, try harder to do it and, we may add, know how to go about it. Just as an intelligent man will, other things being equal, make a more accurate drawing, a better dissection, a neater machine than a stupid man, so, even if inner growth and practice had no efficacy, the ten-year-old would do better than a five-year-old because he had gained a general fund of knowledge and sense.

## SPELLING

How children learn to spell English words would seem to be a fairly easy thing to find out. There is such an abundance of data and the process involves so few factors that the causes of good and bad spelling would seem to be among the first facts for students of children to find out. The practical importance of the discovery should, one would suppose, have made it one of the early triumphs of child study; for all sorts of remedies had been proposed and all sorts of methods of teaching had been in vogue.

Oral spelling, written spelling, sentence writing, spelling books, no spelling books, extensive reading, etc., — all had been indorsed each as the way to make good spellers. Individual experience and expert opinion were evidently incapable of settling this simple question of a method to get children to remember the letters corresponding to words. In fact, the pessimists have claimed that, the more expert opinion deemed itself, the worse the spelling grew. If any one method was the right one, there was a tremendous waste of time in the use of the others.

To Dr. J. M. Rice belongs the credit of having seen the necessity of an investigation of the actual facts. Dr. Rice tested the abilities of children taught by all the different methods, of children who had, some 15, some 30, some 40 minutes of spelling work daily, of children who read largely, and who read but little. He made the brilliant, if exasperating, discovery that it made no difference. Fifteen or forty-five minutes' drill, reading habits or no reading habit, oral or written — all were alike in the spelling produced. I have not permission to quote his report in full, but the following abstracts and quotations present the essentials of his method and results. A full account may be found in the April and June numbers of the *Forum* for 1897.

Dr. Rice tested over 33,000 children with a list of words (50 for the fourth and fifth-year classes, 75 for the sixth, seventh, and

eighth). He also examined the spelling of many of these in the case of compositions written on the basis of a story prepared for the purpose. The following were the words used in the two tests: —

Fourth and fifth-year test: running, slipped, listened, queer, speech, believe, weather, changeable, whistling, frightened, always, changing, chain, loose, baking, piece, receive, laughter, distance, choose, strange, picture, because, thought, purpose, learn, lose, almanac, neighbor, writing, language, careful, enough, necessary, waiting, disappoint, often, covered, mixture, getting, better, feather, light, deceive, driving, surface, rough, smooth, hopping, certainly.

Additional words for higher test: grateful, elegant, present, patience, succeed, severe, accident, sometimes, sensible, business, answer, sweeping, properly, improvement, fatiguing, anxious, appreciate, assure, imagine, peculiar, character, guarantee, approval, intelligent, experience, delicious, realize, importance, occasion, exceptions, thoroughly, conscientious, therefore, ascending, praise, wholesome.

Words omitted in higher test: because, thought, writing, language, feather, light, surface, rough, smooth.

These words were included in sentences dictated to the children, e.g., "While running he slipped. I listened to his queer speech, but I did not notice any of it."

The following table, adapted from Table No. 2 of Dr. Rice's account, gives the percentages of words correctly spelled, in connection with other data:

AVERAGES FOR INDIVIDUAL SCHOOLS

| City | School | 4th Year | | | 5th Year | | | 6th Year | | | 7th Year | | | 8th Year | | | School Av., Sentence-Test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | |
| 1 | A | 67.6 | — | — | 79.6 | — | 45 | 77.2 | — | 20 | 76.7 | — | 25 | — | — | — | 77.1 |
| 1 | B | — | — | — | — | — | — | — | — | — | — | — | — | 82 | 99.6 | 20 | 75 |
| 1 | C | 61.8 | 96.8 | 50 | 72.6 | 97.4 | 50 | 77.7 | 98.8 | 50 | — | — | 40 | 86.1 | — | 30 | 77.6 |
| 7 | A | 71 | 96.7 | 45 | 81.8 | 98.4 | 35 | 71.5 | 98.2 | 40 | 78 | 98.7 | 30 | 85.8 | 99 | 30 | 75.2 |
| | B | 77 | 95.9 | 30 | 73.6 | 97.8 | 20 | 64.2 | 97.8 | 20 | 73.1 | — | — | 84.9 | — | 30 | |
| | A | 68.6 | 97.5 | 40 | 79.4 | 98.3 | 15 | 73.4 | 98.6 | 40 | — | 99.4 | 40 | — | 99.4 | 35 | |
| 7 | B | 64.5 | 97 | — | 75 | — | 30 | 71.1 | — | 45 | 77.2 | — | 30 | 87.2 | 99.4 | . | 77.9 |
| | A | 75.8 | 97.9 | 20 | 81.1 | — | 40 | 80 | — | 50 | 81.1 | — | 15 | 86.7 | 99.3 | 30 | |
| 7 | B | — | 97.5 | — | — | 97.6 | — | — | 97.8 | 35 | — | 98.7 | 30 | . | 99.4 | 15 | |
| | A | — | 97.4 | 35 | — | 98.6 | 15 | 66.5 | 99.1 | 45 | 85.6 | 99.2 | 30 | . | . | . | |
| 9 | B | 70.8 | — | 40 | 71.3 | — | — | 72.8 | — | 35 | — | — | 50 | — | — | — | 76.6 |
| | A | 66.6 | 96.1 | — | 78 | 97.6 | — | 73.2 | 98.7 | 35 | 86.5 | 99.4 | 60 | — | — | — | |
| 9 | B | 66.4 | 96.8 | — | 74.8 | 97.9 | 45 | 75.1 | 98.4 | 45 | — | 99.2 | — | — | — | — | 77.7 |
| | A | 68.4 | — | — | 76.8 | — | — | 76.1 | — | 40 | 84.7 | — | 20 | — | — | — | |
| 9 | B | 66 | — | — | 70 | — | — | 79.4 | — | 35 | 80 | 99.2 | 20 | 83.5 | 99.2 | . | 77.9 |
| | C | 66.4 | — | 40 | 83.2 | — | — | — | — | — | 79.5 | 98.6 | — | 82.5 | 99.1 | . | |
| 10 | A | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 76.2 |
| | B | 61.4 | 96.6 | — | 76.6 | 98.6 | — | 72.7 | 99.2 | — | — | — | — | — | — | — | — |
| 10 | A | 75.9 | 98.3 | 35 | 77.2 | 98.9 | 20 | — | — | 20 | — | — | — | — | — | — | |
| | B | 61.2 | — | — | 70.4 | — | — | 63.4 | — | — | — | — | — | — | — | — | |
| 11 | A | 63.6 | — | 25 | 70.6 | — | — | 65.8 | — | 25 | 76 | — | 30 | 86.4 | — | 40 | 72 |

Small a indicates first half, and small A second half, of school year.

AVERAGES FOR INDIVIDUAL SCHOOLS (*Continued*)

| City | School | 4th Year | | | 5th Year | | | 6th Year | | | 7th Year | | | 8th Year | | | School Av., Sentence-Test | City | School |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | Sentence-Test | Composition-Test | Minutes Daily | | | |
| 11 | B | B 76.4 | 96.3 | — | 74.6 | 97.9 | — | 74 | 98.5 | — | 80 | — | — | 86.7 | 99.1 | 40 | 79.4 | 11 | B |
| | | A 79.8 | 97.9 | 35 | 81.8 | 98.5 | 25 | — | — | 30 | | 98.8 | 40 | | | | | | |
| 12 | A | B 53.2 | — | — | 66.4 | — | — | 75 | — | — | — | — | — | 86.3 | — | — | 73.9 | 12 | A |
| | | A 63.1 | — | — | 73 | — | — | 75.7 | — | — | 78.3 | — | — | 90.2 | — | — | | | |
| 12 | B | B 53.3 | — | — | 74.4 | — | 18 | 73.1 | — | — | — | — | — | 90.3 | — | — | 79.0 | 12 | B |
| | | A 67.2 | — | 18 | 79 | — | 10 | 78.4 | — | 9 | 90 | — | 12 | 94.6 | — | 12 | | | |
| 15 | B | B — | — | — | 73 | 96.8 | — | 57 | 97.7 | — | 76.7 | 98.3 | — | 83.9 | 99 | — | 73.4 | 15 | B |
| | | A — | — | — | 73.4 | 97.4 | — | 71.5 | 98.1 | — | 83.3 | 98.7 | — | 87.2 | 99.4 | — | | | |
| 15 | D | B — | — | — | 81.6 | — | — | 68.3 | — | — | 74.7 | — | — | 86.2 | — | — | 78.8 | 15 | D |
| | | A 74.3 | — | 20 | 83.6 | — | 20 | 72.7 | — | 20 | 84 | — | 20 | 88.6 | — | 20 | | | |
| 15 | E | B 66.2 | 97 | — | 74.4 | 97.8 | — | 72.8 | 98.5 | — | — | — | — | — | — | — | 77.3 | 15 | E |
| | | A 70.8 | 96.6 | 15 | 79.4 | 98.3 | 20 | 69.6 | 98.1 | 20 | 80.6 | 98.7 | 20 | 89.4 | 99.2 | 20 | | | |
| 15 | H | B 67.2 | — | — | 76.2 | — | — | 69.8 | — | — | 81.4 | — | — | 89.9 | — | — | 77.9 | 15 | H |
| | | A 69.1 | — | 20 | 79.1 | — | 25 | 76.2 | — | 25 | — | — | 25 | 89.4 | — | 25 | | | |
| 16 | A | B 62.6 | 97.4 | — | 73.6 | 98.5 | — | 61.9 | 97.6 | — | 71.1 | 98.2 | — | 84 | 99.1 | — | 72.0 | 16 | A |
| | | A 59.2 | 97.9 | 20 | 76.4 | 98.6 | 15 | 68.7 | 98.7 | 20 | 72.8 | 98.8 | 20 | 89.9 | 99.4 | 6 | | | |
| 16 | B | B 68.4 | — | — | 70.6 | 98.5 | — | — | 98.1 | — | 71.3 | 98.5 | — | 81.2 | 98.9 | — | 72.7 | 16 | B |
| | | A 65 | 97.9 | 20 | 74.4 | 98.2 | 20 | — | 97.7 | 15 | 75.3 | 99.3 | 10 | 80.2 | 99.2 | 5 | | | |
| 19 | A | B 61.8 | — | — | 66.8 | — | — | 68.8 | — | — | 78 | — | — | 84.3 | — | — | 73.8 | 19 | A |
| | | A — | — | 20 | 76.6 | — | 40 | 72 | — | 35 | 84 | — | — | — | — | — | | | |
| 19 | B | B 57.4 | — | — | 73 | — | — | 61.3 | — | — | 69.5 | — | — | 85 | — | — | 73.3 | 19 | B |
| | | A 68.4 | — | 40 | 78.2 | — | — | 69.5 | — | 30 | 84 | — | 30 | 86.8 | — | — | | | |

Small B indicates first half, and small A second half, of school year.

[Of the facts summed up in it Dr. Rice writes as follows:]

"In the vast majority of instances the results are very close when the averages for entire buildings are compared. In fifteen of the twenty-one schools on my list, the averages on the second test, as the table shows, run from 73.3 to 77.9. Second, while the results in the lower grades of different schools show considerable variation, those in the eighth-year classes, which represent the end of the school course, are remarkably even. In twelve of the seventeen eighth-year grades the averages are from 84 to 88, the A and B classes being taken together. And in fifteen of a total of twenty sets of eighth-grade compositions examined for spelling, the variations were only three-tenths of one per cent, the results lying between 99.1 and 99.4, the A's and B's being taken as one. These facts are doubly remarkable when we consider that the twenty-one schools not only represent institutions in many sections of the country, but that they are samples of schools conducted under all conceivable conditions. For example, No. 7 is a Western city of moderate size, while No. 15 is a large city in the East. Again, most of the children attending School A, No. 7, are of American parentage, and their home surroundings are particularly favorable, while the children attending School B, No. 7, represent the foreign laboring element. Further, from a pedagogical standpoint, all varieties of schools are included; some of them belonging to the most mechanical, while others are among the most progressive in our country.

"If the best results had been secured in the mechanical and the poorest in the progressive schools, the question would arise, whether the small additional return would warrant the latter in placing additional pressure on spelling at the expense of other subjects. But even this question does not arise; for it did not happen that the results in most cases were best in mechanical schools. Indeed, in both the mechanical and the progressive schools the results were variable; so that while, in some instances, the higher figures were secured by the former, in others they were obtained by the latter; and the same is true of the lower figures. For example, School B, No. 11, in which the best average (79.4) was obtained, belongs to a very progressive system; while School A, No. 12, which made only 73.9, belongs to one of our most mechanical systems. And it is a peculiar incident that, in both these cities, the results in the only other school examined are exactly reversed, although the environment is about the same.

"Further, just as it is impossible by the results to distinguish the mechanical from the progressive schools, so it is impossible to distinguish the schools attended by the children of cultured parents from those representing the foreign laboring element; the results from this standpoint also varying equally. Consequently, so far as spelling is concerned, the influence of environment appears to be insignificant.

"The second point to which I have referred, namely, the small variation in the eighth-year results, — regardless of how much time had been devoted to spelling, or what methods had been employed, or under what home influences the children had been reared, — is also well worthy of consideration. And it is no less striking that the same level was reached in the end, regardless of what had been accomplished in the lower grades.

— a fact which becomes obvious on comparing the results in the eighth-year classes with the average obtained by the entire school. In the composition-test, where the results in fifteen of the twenty sets of eighth-year papers were within three-tenths of each other, this fact is still more clearly demonstrated.

* * * * * * * *

"Finally, as in most localities the general results were nearly equal — those secured under the same system of instruction varying as much as those obtained under different systems — it is clear that the remedy does not lie in a change of method, nor in an increase of time. And this conclusion accords with the fact that the dissatisfaction with spelling is as great in communities where this subject constitutes a special feature as in those where spelling plays only a subordinate part in the schools."

[The reader will note that the results were just as good in the case of schools devoting 15 or 20 minutes to spelling as in the case of those giving 40 or 50.]

[Dr. Rice also tabulated his results, or representative samples of them, so as to show more clearly the influence of age, intelligence (according to the teachers' opinions) and home environment. The following are those parts of his tables referring to the sentence-tests:]

TABLE NO. 1

| Sentence-Test | City | Fourth Year | | | Fifth Year | | | Sixth Year | | | Seventh Year | | | Eighth Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age | No. of Pupils | Genl. Average | Age | No. of Pupils | Genl. Average | Age | No. of Pupils | Genl. Average | Age | No. of Pupils | Genl. Average | Age | No. of Pupils | Genl. Average |
| | 1 | 9–11 | 72 | 69.5 | 10–12 | 56 | 81.6 | 12–13 | 22 | 79.9 | 12–14 | 43 | 76.7 | 12–14 | 35 | 86.9 |
| | 1 | 12–15 | 39 | 59.1 | 13–15 | 38 | 78.8 | 14–16 | 10 | 68.3 | 15–17 | 21 | 77.8 | 15–17 | 52 | 84.9 |
| | *7 | 8–10 | 47 | 68.9 | 10–12 | 56 | 81.4 | 12–13 | 22 | 79.2 | 12–14 | 43 | 76.6 | 12–14 | 35 | 87.2 |
| | *7 | 11–13 | 27 | 59. | 13–15 | 38 | 78.9 | 14–16 | 10 | 68.3 | 15–17 | 21 | 77.8 | 15–17 | 52 | 84.8 |
| | †9 | 9–11 | 55 | 70.2 | 10–12 | 38 | 75.5 | 11–13 | 38 | 73.1 | 12–14 | 44 | 86.2 | | | |
| | †9 | 12–15 | 51 | 64.7 | 13–15 | 45 | 76.2 | 14–16 | 55 | 74.7 | 15–17 | 32 | 86.5 | | | |

* School A. † School B.

TABLE NO. 2

| No. of Cities | Grade | No. of Classes | No. Pupils Intellect 1 | Average | No. Pupils Intellect 2 | Average | No. Pupils Intellect 3 | Average | No. Pupils Intellect 4 | Average |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 4 | 16 | 112 | 78.7 | 169 | 70.5 | 152 | 58.8 | 54 | 52.1 |
| 3 | 5 | 16 | 117 | 86. | 239 | 77.7 | 166 | 71.1 | 59 | 61.6 |
| 3 | 6 | 23 | 164 | 88.7 | 263 | 84.3 | 182 | 78. | 69 | 73.7 |
| 3 | 7 | 19 | 116 | 93.4 | 216 | 88.3 | 155 | 77.5 | 59 | 79.2 |
| 2 | 8 | 8 | 56 | 94. | 99 | 89.3 | 97 | 87.8 | 20 | 81.5 |

TABLE NO. 3

| | Grade | No. of Cities | No. of Classes | No. of Pupils | General Average | Children of Foreign Parentage | Average | No. of Children hearing Foreign Language at home | Average | Children of Unskilled Laborers | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sentence-Test | Fourth . . | 4 | 27 | 821 | 64.7 | 155 | 65.2 | 159 | 64.9 | 129 | 62 5 |
| | Fifth . . | 4 | 29 | 829 | 76. | 153 | 77.4 | 157 | 76.7 | 129 | 74.5 |
| | Sixth . . | 4 | 22 | 778 | 69.7 | 185 | 69.6 | 165 | 70.3 | 119 | 70.4 |
| | Seventh . | 4 | 18 | 566 | 78.8 | 81 | 82.5 | 52 | 81.5 | 55 | 76.8 |
| | Eighth . . | 4 | 19 | 528 | 83.1 | 72 | 83.2 | 64 | 83.2 | 76 | 85. |

An examination of these tables will show (1) that within the same grade the younger pupils do better, presumably because they are brighter; (2) that success in spelling is correlated with intelligence in the teacher's estimation; (3) that home reading, refined companionship, English rather than foreign associations play no part in causing good spelling.

Dr. Rice further tabulated the results in accordance with the methods of instruction used in the different schools, interviewing some two hundred teachers for that purpose. He does not give the detailed results, but assures us that there is no reason to believe that there is any clear choice between oral and written spelling, writing isolated words and writing sentences, the sight or flash method and its absence. Phonic reading does not make bad spellers, nor do written language work and wide general reading make good spellers. "In brief," says he, "there is no direct relation between method and results. . . . The results varied as much under the same as they did under different methods of instruction."

There is a value to this study besides its information concerning methods of teaching spelling. It teaches the fallibility of judgments based on individual experience, the specious character of many of the most plausible arguments; it teaches also that the enthusiasm and mother-wit of the teacher may make a method seem good which is no better than others, that those of us who spend our time in talking about teaching are often talking so far above and off the stratum of fact that our dicta are vain, and, last but not least, that many of our quarrels are probably about matters which really don't make any difference. If the

scientific study of children did no more than teach these lessons to its followers it would still be an invaluable force in education.

If we may permit ourselves to criticise so good a piece of work as Dr. Rice's we may add another lesson gained from a possible mistake of his own. When Dr. Rice found that the evidence proved that none of the alleged factors made any difference in the spelling product, he dropped science, allowed himself to speculate, and said: "The facts here presented, in my opinion, will admit of only one conclusion, viz., that the results are not determined by the methods employed, but by the ability of those who use them. In other words, the first place must be given to the personal equation of the teacher, while methods and devices play a subordinate part."

Dr. Rice's desertion of facts for opinion was hasty, for there are real causes for good and bad spelling other than the one he opines. Miss E. K. Carmen, at my suggestion, tested the hypothesis that chronic bad spelling was due to comparative failure to observe and attend to the spelling of words, to the habit of reading without really seeing words in detail. From the report of her study I will quote a part. It appeared in the *Journal of Pedagogy* for October, 1900.

> That poor spelling occurs among people mentally incapacitated, or of slight education, or in young children with poor vision, is not surprising; but that it prevails among people completely endowed, and with the best educational advantages, presents something of an anomaly.
>
> It has seemed to me that poor spelling is due to poor observation; that is, observation *of the words* themselves,[1] and I have lately taken some

[1 Miss A. E. Wyckoff noted in a somewhat indefinite way this same fact, but seems to refer it to a quality of attention in general rather than to a particular habit of attending to words. She wrote (*Pedagogical Seminary,* Vol. II, p. 450): "Constitutional bad spelling may, in part, be the result of a strong natural bent toward selective attention." Her data were observations of two bad spellers, of whom she says, "Conspicuous as thinkers, they were comparatively slow readers, having the habit of reading one word at a time. Almost all their mistakes in spelling occurred in the latter half of the word. . . . Further tests made it clear that attention was habitually directed to the beginning of the words. Here, then, seemed to be one type of constitutional bad speller proved by subsequent tests to have good powers of

pains to test this theory. The people taken for the experiments were sixteen adults, all of whom, in addition to having completed a high-school course, had spent, on an average, two years more in study. These comprised eight good spellers and eight poor ones. This fact was assured in some cases by the persons' own word for it, in others by evidence from daily work at college during the present year. In either case, if there was any doubt, dictation was given them for this purpose.

To them was given the following printed page from Appleton's Fourth Reader, containing one hundred mis-spelled words. They were asked to go through the paper as quickly as possible, marking each mis-spelled word:

MARK EVERY WORD THAT IS NOT SPELLED CORRECTLY

1. On the 3d of September, 1832, inteligence was broght to the collecter of Tinnevelly that som wildd eliphants had appeared in the neighborhod. A hunting party was imediately formed, and a large number of nattive hunters were engaged. We left the tents, on horsback, at half-past sevin o'clock in the morrning and rode thre miles to an open spote, flanked on one sid bye Rice-fields, and on the other by a jungle.

2. After waiting som time, Captain B——— and myself walked acros the rice-fields to the shad of a tree. There we herd the trumpett of an elephant; we reshed acros the rice-fields up to our knes in mud, but all in vain, thogh we came upon the trak of one of the animels, and then ran five or six hundredd yards iutoo the jungle.

3. After varius false allarms, aud vane endevors to discuvor the obgects of our chace, the colector went into the jungle, and Captin B——— and myself into bed of the stream' where we had sen the traks; and here it was evedent the elaphents had passed to and fro. Disapointed and impasient, we allmost determened to giv up the chace and go home; but shots fird just before us reanimated us, aud we proceded, and found the collecter had just firred twicce.

4. Of we went throuh forest, over ravin, and through strems, till att last, at the top of the ravine, the eliphants were seen. This was a momant of excitment! We wer all scatered. The collecter had taken the midle path; Captain B———, some huntsmen, and myself took to the feft; and the other hunters scrabled down that to the rite. At this momunt I did not see enything but after advanceing a few yards, the hugh hed ef an elephunt shaking abuve the jungle, withen ten yards of us, burst sudenly upon my view.

5. Captain B——— ande a hunter justt befor me; we al fired at the same moment, and in so dirrect a line that the percussion cap of my gun hitt the hunter, whome I thougt at first I had shoot. This acident, thogh

visualization and sound imaging and fair retention, but gifted with a natural mode of attention unsuited to purposes of spelling." — E. L. T.]

it prouved slight, troubled me a litle. The grate excitment ocasioned by seeing, for the first tim, a wild best at liberty and in a state of natur, product a sensation of hop and fear that was intens.

The time of each in marking the words was accurately recorded. The averages ran thus:

| | Time—Seconds | Word Omitted |
|---|---|---|
| Good spellers . . . . | 130.1 | 8.9 |
| Poor " . . . . | 199.6 | 28.1 |

Note. — The average deviation in time taken by the good spellers was ± 50.6 seconds; by the poor spellers, ± 62.8. The average deviation in the number of words omitted by the good spellers was ± 3.9; by the poor spellers, ± 12.9.

One of the poor spellers, B, who was in other respects rather an exceptional case, made a record of time taken, 112 seconds, and words omitted, 64.

If we take the remaining seven as representative of poor spellers, we find the average time to be 212.1 seconds, with an average deviation of ± 59.4 seconds, while the average number of words omitted is 23, with an average deviation of ± 9.6.

The test was applied to blind people, whose observation is tactual. The same page was reproduced in point and given to four good spellers and two poor ones among the pupils at the Indianapolis Institute for the Blind.

The records are given complete:

| Good Spellers | Time min. | Time sec. | Words Omitted |
|---|---|---|---|
| 1. Eighth grade—congenital | 8 | 10 | 31 |
| 2. Eighth grade—blind at 2 years | 11 | | 26 |
| 3. Graduate—blind at 4 years | 11 | 30 | 21 |
| 4. Seventh grade—blind at 4 days | 5 | | 57 |
| Poor Spellers | | | |
| 5. Seventh grade—blind at 6 years | 11 | 20 | 66 |
| 6. Senior—blind at 2 years | 12 | 5 | 55 |

Note. — Of course, with most people reading with the fingers requires a great deal more time than with the eyes.

The averages are:

| | Time—min. | sec. | Words Omitted |
|---|---|---|---|
| Good spellers . . . | 8 | 55 | 33.7 |
| Poor " . . . | 11 | 42.5 | 60.5 |

The fourth person here is also exceptional, and the average without this one is: time, 10 minutes 12 seconds, and words omitted, 26.

Of course, as the number of cases is so small, these averages cannot pretend to represent good and poor spellers in general. They are inserted merely as a clearer representation of the table in the text.

After the marking of words there were made with the sixteen, other tests of observation, as follows:

They were given printed pages that were similar, on which to mark, as quickly as they could, all words containing two given letters: in the first set s and p, the second l and o, the third e and v. The averages were:

| | Time (to page) | Omissions (to page) |
|---|---|---|
| Good spellers . . . | 99.7 sec. | 3.6 |
| Poor " . . . | 134.7 " | 6.2 |

Note. — The average deviation in time taken by the good spellers was ± 28.1 seconds, by the poor spellers, ± 26.2 seconds.

The average deviation in the number of omissions by the good spellers was ± .8, by the poor spellers, ± 1.9.

Leaving out again the record of case B, the poor spellers have an average time to the page of 136.5 seconds, with an average deviation of ± 29 seconds, while the average number of omissions is 5.6, with an average deviation of ± 1.8.

The next test was with two cards containing each ten letters of various sizes, and irregularly placed. These were exposed to them for five seconds, after which they wrote as many of the letters as they could.

The average mistakes were, for the good spellers, 6.6; for the poor ones, 8.2.

Note. — The average deviation for good spellers was ± 3.65, and for poor ones, ± 4.7. Omitting case B, the poor spellers had an average of 7 mistakes, with an average deviation of ± 4.1.

The last test consisted of four cards on which were forms, such as triangles, circles, squares, lines parallel and otherwise, and some figures of undefinable shape. These were also exposed for five seconds, after which they were to be drawn upon paper. The average mistakes were: for the good spellers, 11; for the poor ones, 11.6.

Note. — The average deviation for good spellers was ± 2.2, and for the poor ones, ± 3.6. Omitting case B, the poor spellers had an average of 10.7 mistakes, with an average deviation of ± 3.2.

By noticing the results of the three tests given for observation in other things than words, we see a decrease of the difference in observational ability between the two classes as the data to be observed become more and more unlike words. Ability to spell well, therefore, probably implies not a *general* habit or power of observation, but a *special* ability to notice small differences in *words*.

Whether any specific methods can be used in the class-room to secure the habit of attention to the spelling of words during reading is still a question. It would seem likely.

## CHILD STUDY REPRINTS

# THE ATTITUDE OF CHILDREN TOWARD PUNISHMENT

The control of children depends partly on a concrete practical comprehension of their make-up, their reaction to different sorts of incentives and deterrents, their appreciation of laws, rules, advice, and so forth. The study of children may provide data which may increase a teacher's general information about this side of child life and so assist to the concrete, practical comprehension or tact ultimately necessary in dealing with matters of discipline and moral education. A number of studies have attempted to do this with greater or less success. One of the most interesting of their conclusions concerns the existence in young children of an overwhelming tendency to regard the letter rather than the spirit of laws, to look on justice not as equity, but as a fate overtaking certain definite transgressions; to regard punishments not as remedial or preventive agencies, but as natural results of certain acts, regardless of intentions. This attitude comes out clearly in the following characteristic account of boy justice, taken from Mr. John Johnson, Jr.'s excellent study, *Rudimentary Society Among Boys.*[1] Mr. Johnson studied the social habits of the boys living together in an institution possessed of eight hundred acres of land and quite isolated from outside influences. The study, as a whole, is well worth reading.

Disputes arising from their peculiar customs of ownership are settled by boys assembled at the place where the controversy is carried on. Most commonly this is in the play-room, where they can be free from observation. When Black and Landreth found the nest of a dove in the pines, seeing no mark of prior owners upon the tree, they took the eggs and brought them to the house. As they sat in the play-room, with needles and straws, preparing the eggs for their cabinet, Delphey overheard their talk, and questioned them about the spot where the nest was discovered. He soon con-

[1] Johns Hopkins Press.

vinced himself that the nest was one that he had found but a few days before, and on which he had placed the mark of himself and his partners. When he was satisfied on that point, he at once laid claim to the eggs. Landreth and Black angrily refused to give them up, and they were soon hot in dispute. Under the law made for such cases, the question of ownership is a nice one. It is granted on both sides that if Delphey, the first finder, is to retain a good title, his label must either remain upon the trunk of the tree, or else lie in sight upon the ground beneath, where it has fallen by accident. If neither alternative is complied with, any subsequent finder may either take the nest or mark the tree with his own label.

By this time a knot of a dozen boys, who had been idling about, had formed around Delphey, listening intently. In a few moments he called Duvall, his partner, for confirmation, and with the utmost particularity related the circumstances in which he had found the nest. Delphey told of the route they took over the stream, through the swamp, and up the hill, and mentioned the boys they met on the way, whom he compelled to corroborate his assertions. By the time Duvall takes up the account, the ring surrounding them has become larger; perhaps twenty boys have gathered, and they listen with strained attention. He proceeds to describe the tree in which the nest was placed, and dwells with convincing minuteness upon its exact situation, upon the color of the bark, the broken limb, the knot half-way up the trunk, and the nailing of the label upon it. To all of his statements it may be that his adversaries, Landreth and Black, assent, only interjecting at intervals the words: "But there wasn't any mark on the tree when we were there." The declarations of either party are addressed as much to the throng around as to their opponents, and it is evident, in the heightened color of the bystanders, in their sparkling eyes, and in their tense muscles, that to them the question is of absorbing interest. Now that the argument of the plaintiffs has been heard in full, there can be no doubt that they marked the nest as they declare; and yet there is nothing to indicate that the defendants have any intention of restoring the property.

Seeing the angry looks and threatening gestures of all the group, one who does not know the school may judge that blows will follow next, and that a general conflict is about to ensue between the partisans of the claimants. Nothing could be farther from the truth. What has occurred is but the ordinary proceeding of a very primitive court of justice. Delphey knows that Black's arms are strong, his fists hard, and his blows rapid. Landreth has no desire to risk the destruction of his treasure in a struggle where, even if he retains it, he is sure to do so at the cost of bruises and blood. As he rises angrily from his seat and pushes through the crowd, he is not seeking space in which to fight, but a witness to establish his title. This body of spectators, who seem intent upon hearing the whole matter and sifting it to the bottom, is — if the name will serve — the folk-moot, the assembly of the people, met to see justice done according to law. Each boy standing in the ring around the orators knows that to-morrow he may be there to maintain his rights before a similar body, in which the plaintiff and the defendant of to-day will alike have

a voice to decide upon his claims. He has a feeling that a decision contrary to established custom, however it may accord with his momentary sympathies, will be treated as a precedent to overthrow his most cherished interests and to prevent the operation of rules upon which he had confidently counted in every venture in which he is engaged. Every boy there is determined upon the entire preservation of the system of law upon which he has based all his hopes of filling his egg-cabinet.

We have turned aside a moment from following the actions of the litigants. The clamor of voices rose louder as Landreth moved off, but it subsided somewhat as he reappeared, accompanied by Miller, on whose testimony he relied. The newcomer rapidly explained to those around that he, too, had seen the nest on the day Landreth took it; he had examined the tree, and Delphey's mark was not upon it; he had searched the ground beneath, and could not find the label there; he would himself have carried off the find but for the fact that he saw only a single egg, and thought it better to put his own claim-mark upon the trunk and wait till more eggs were laid, when he had intended to return and get them. It had happened, however, that during his previous search for nests he had, in marking other discoveries, used up all the labels that he had brought with him, and he had, therefore, been unable to appropriate the tree at the time. It was after he had gone away, and before he could return with a label, that Landreth had found the nest and possessed himself of its contents, which had, meanwhile, been increased to two eggs by the industrious bird.

This evidence ended the trial. Loud cries arose from all parts of the throng. "It's Doggie's nest. It wasn't marked when he found it," said one member of the tumultuous court. "Your mark was blown away, Rufie," exclaimed another; "it's Doggie's nest." No opposition of importance was made, and, the decision being rendered, Delphey and his partner saw their case was lost, and slowly walked away. Landreth and Black, who retained the eggs, returned to their work of blowing them with straws. The making of the claim, the trial, and the decision, occupied less than half an hour. If not sure, this justice is at least swift.

A word may here be given to the ethical questions brought up by this decision. It was admitted by all parties that the two boys had found the nest before Landreth and Black had seen it. Landreth's claims, in the view of equity, would have to yield to Delphey's, who not only found the nest, but marked it, and who, in so far as prior discovery gives any rights, clearly had them all. Landreth's title rested upon a purely technical ground. Yet, with a characteristic analogy to primitive habits of thought, it was considered that the perfect title was obtained by a literal fulfilment of the words of the law, by an exact compliance with its minutest provisions. The law provided that no one should take a nest when the mark was on the trunk beneath or in sight upon the ground. As it had been proved by Miller's testimony that Landreth could not have seen Delphey's label, Delphey's rights vanished.

There can be little doubt that the negligent driving of a tack was all that made Landreth the better owner than Delphey, and that Landreth

was perfectly aware of this fact. When the suitors and judges were questioned as to why such a decision was given, the only reply to be obtained was, "That's the rule." Like Shylock, Landreth might have said: "I stand here for law," and his determination was to maintain to the full every legal privilege. The idea that the law might give advantages the use of which morality could not sanction, is so late a development in the legal history of mankind that we must not regard the absence of such a conception among these boys as an indication of an abnormally low state of moral culture. To look for exalted views of right and wrong among them would be to expect them to reverse the usual processes of mental progress.

John Johnson, Jr., *Rudimentary Society Among Boys*, pp. 36-40.

With this sample of boy justice we may compare one of the results of a study by Miss Margaret E. Schallenberger, reported in full on pages 87–96 of the *Pedagogical Seminary*, Vol. III, entitled "A Study of Children's Rights, as Seen by Themselves." About 3000 children wrote a language lesson after being read the following statement and question:

"Jennie had a beautiful new box of paints, and in the afternoon, while her mother was gone, she painted all the chairs in the parlor, so as to make them look nice for her mother. When her mother came home, Jennie ran to meet her, and said, 'Oh, mamma, come and see how pretty I have made the parlor;' but her mamma took her paints away and sent her to bed. If you had been her mother, what would you have done or said to Jennie?"

Their answers were classified under the following heads:

1. Ignorant.
2. Explained to.
3. Don't do it again.
4. Made to promise.
5. Threatened.
6. Scolded.
7. Clean chairs.
8. Confined.
9. Lose meal.
10. Lose paints.
11. Sent to bed.
12. Whipped.
13. Punished.
14. Peculiar punishments.

Replies 1, 2, 3 and 4 testify roughly to a sense of equity, of consciousness of intention as the criterion of good or bad, while 8, 9, 10, 11, 12, 13 and 14 show, again roughly, the tendency to regard punishment as retaliation or as a fate overtaking certain acts, regardless of the intention that produced them. As children grow older the first sort of replies increase, while the second sort decrease. From the detailed table given by Miss Schallenberger I reckon the percentages for the different ages to be as follows:

| | Years, | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boys | Retaliation or Fate | 87.5 | 80.9 | 80. | 84. | 77. | 75. | 73. | 67. | 49. | 49. | 33. |
| | Equity . . . . . | 8. | 9. | 7. | 9. | 12. | 9. | 14. | 16. | 32. | 36. | 59. |
| Girls | Retaliation or Fate | 92.5 | 82.5 | 81. | 70. | 67. | 64. | 60. | 55. | 49. | 37. | 36. |
| | Equity . . . . . | 3. | 9. | 9. | 10. | 17. | 21. | 24. | 33. | 36. | 48. | 49. |

The following quotation from Miss Schallenberger states the general fact shown by the figures:

Almost as striking as children's reasons for punishment are their attitudes regarding the motive that lies back of the action. The intellectual and moral condition of a man can be fairly estimated by his ability and willingness to judge of the motives which actuate those about him. A marked difference in children regarding motives is noticeable.

The young child thinks of the result of an action. If the result is bad, punishment should follow; if not, the offender should be allowed to go free. A ten-year-old boy writes: "If the girl made the chairs nicer than they were, I would tell her that she was a good girl; and if she soiled the chairs, I would give her a whipping." A little girl voices the opinion of many another when she says: "If I were her mother, I would have whipped her for spoiling the parlor chairs."

Another one, nine years old, seems to us wise elders inconsistent when she writes: "Jennie thought that she was making the chairs pretty. But she spoilt the chairs. I would have taken her and I would whipped her and sent her to bed for the rest of the day. I would told her that she was a bad little girl."

Equally regardless of good intention is the statement of the child who says: "I would whip her and send her to bed out any supper"; and then adds, as if it were of no importance, "Jennie thought it would make her mother glad."

The older children, on the contrary, think of the motive that led to the action. If this be good, punishment should be light or not at all. Sometimes, because of this feeling, they grow indignant over the treatment of Jennie by the mother in the story.

# HEREDITY AND ENVIRONMENT

The great importance to educational theory of knowledge concerning the relative influence of what our natures are at birth and what our education is afterward contrasts with its small amount. How far our course in life is determined for us before we start by the organizations we are born with is one of the first problems of educational theory, a problem concerning which speculation and opinion too often run riot.

One of the few really earnest and hopeful attempts to answer this question is Mr. Francis Galton's "Study of Twins," an account of which is found in his *Inquiries into Human Faculty* (London, 1883) and which is here reprinted in full. This study is very valuable, and, unfortunately, very inaccessible; it may also serve as a sample of the careful investigation of the fundamental laws of mental inheritance for which educational science owes Galton a great debt; it will do its best service if it introduces the reader to the general treatises on heredity of Galton and Karl Pearson or induces him to collect data concerning heredity from his own neighborhood.

## HISTORY OF TWINS

Pages 216–243 of *Inquiries Into Human Faculty*

The exceedingly close resemblance attributed to twins has been the subject of many novels and plays, and most persons have felt a desire to know upon what basis of truth those works of fiction may rest. But twins have a special claim upon our attention; it is, that their history affords means of distinguishing between the effects of tendencies received at birth and of those that were imposed by the special circumstances of their after-lives. The objection to statistical evidence in proof of the inheritance of peculiar faculties has always been: "The persons whom you compare may have lived under similar social conditions and have had similar ad-

vantages of education, but such prominent conditions are only a small part of those that determine the future of each man's life. It is to trifling accidental circumstances that the bent of his disposition and his success are mainly due, and these you leave wholly out of account — in fact, they do not admit of being tabulated, and therefore your statistics, however plausible at first sight, are really of very little use." No method of inquiry which I had previously been able to carry out — and I have tried many methods — is wholly free from this objection. I have therefore attacked the problem from the opposite side, seeking for some new method by which it would be possible to weigh in just scales the effects of Nature and Nurture, and to ascertain their respective shares in framing the disposition and intellectual ability of men. The life-history of twins supplies what I wanted. We may begin by inquiring about twins who were closely alike in boyhood and youth, and who were educated together for many years, and learn whether they subsequently grew unlike, and, if so, what the main causes were which, in the opinion of the family, produced the dissimilarity. In this way we can obtain direct evidence of the kind we want. Again, we may obtain yet more valuable evidence by a converse method. We can inquire into the history of twins who were exceedingly unlike in childhood, and learn how far their characters became assimilated under the influence of identical nurture, inasmuch as they had the same home, the same teachers, the same associates, and in every other respect the same surroundings.

My materials were obtained by sending circulars of inquiry to persons who were either twins themselves or near relations of twins. The printed questions were in thirteen groups; the last of them asked for the addresses of other twins known to the recipient, who might be likely to respond if I wrote to them. This happily led to a continually widening circle of correspondence, which I pursued until enough material was accumulated for a general reconnaisance of the subject.

There is a large literature relating to twins in their purely surgical and physiological aspect. The reader interested in this should consult "Die Lehre von den Zwillingen," von L. Kleinwächter, Prag, 1871. It is full of references, but it also is unhappily disfigured by a number of numerical misprints, especially in page 26. I have not found any book that treats of twins from my present point of view.

The reader will easily understand that the word "twins" is a vague expression, which covers two very dissimilar events — the one corresponding to the progeny of animals that usually bear more than one at a birth, each of the progeny being derived from a separate ovum, while the other event is due to the development of two germinal spots in the same ovum. In the latter case they are enveloped in the same membrane, and all such twins are found invariably to be of the same sex. The consequence of this is, that I find a curious discontinuity in my results. One would have expected that twins would commonly be found to possess a certain average likeness to one another; that a few would greatly exceed that average likeness, and a few would greatly fall short of it. But this is not at all the case. Extreme similarity and extreme dissimilarity between twins of

the same sex are nearly as common as moderate resemblance. When the twins are a boy and a girl, they are never closely alike; in fact, their origin is never due to the development of two germinal spots in the same ovum.

I received about eighty returns of cases of close similarity, thirty-five of which entered into many instructive details. In a few of these not a single point of difference could be specified. In the remainder, the color of the hair and eyes was almost always identical; the height, weight, and strength were nearly so. Nevertheless, I have a few cases of a notable difference in height, weight, and strength, although the resemblance was otherwise very near. The manner and personal address of the thirty-five pairs of twins are usually described as very similar, but accompanied by a slight difference of expression, familiar to near relatives, though unperceived by strangers. The intonation of the voice when speaking is commonly the same, but it frequently happens that the twins sing in different keys. Most singularly, the one point in which similarity is rare is the handwriting. I cannot account for this, considering how strongly handwriting runs in families, but I am sure of the fact. I have only one case in which nobody, not even the twins themselves, could distinguish their own notes of lectures, etc.; barely two or three in which the handwriting was distinguishable by others, and only a few in which it was described as closely alike. On the other hand, I have many in which it is stated to be unlike, and some in which it is alluded to as the only point of difference. It would appear that the handwriting is a very delicate test of difference in organization — a conclusion which I commend to the notice of enthusiasts in the art of discovering character by the handwriting.

One of my inquiries was for anecdotes regarding mistakes made between the twins by their near relatives. The replies are numerous, but not very varied in character. When the twins are children, they are usually distinguished by ribbons tied around their wrist or neck; nevertheless the one is sometimes fed, physicked, and whipped by mistake for the other, and the description of these little domestic catastrophes was usually given, by the mother, in a phraseology that is somewhat touching by reason of its seriousness. I have one case in which a doubt remains whether the children were not changed in their bath, and the presumed A is not really B, and *vice versa*. In another case, an artist was engaged on the portraits of twins who were between three and four years of age; he had to lay aside his work for three weeks, and, on resuming it, could not tell to which child the respective likenesses he had in hand belonged. The mistakes become less numerous on the part of the mother during the boyhood and girlhood of the twins, but are almost as frequent as before on the part of strangers. I have many instances of tutors being unable to distinguish their twin pupils. Two girls used regularly to impose on their music teacher when one of them wanted a whole holiday; they had their lessons at separate hours, and the one girl sacrificed herself to receive two lessons on the same day, while the other one enjoyed herself from morning to evening. Here is a brief and comprehensive account:

"Exactly alike in all, their schoolmasters could never tell them apart; at dancing parties they constantly changed partners without discovery; their close resemblance is scarcely diminished by age."

The following is a typical schoolboy anecdote:

"Two twins were fond of playing tricks, and complaints were frequently made; but the boys would never own which was the guilty one, and the complainants were never certain which of the two he was. One head-master used to say he would never flog the innocent for the guilty, and another used to flog both."

No less than nine anecdotes have reached me of a twin seeing his or her reflection in a looking-glass, and addressing it in the belief that it was the other twin in person.

I have many anecdotes of mistakes when the twins were nearly grown up. Thus:

"Amusing scenes occurred at college when one twin came to visit the other; the porter on one occasion refusing to let the visitor out of the college gates, for, though they stood side by side, he professed ignorance as to which he ought to allow to depart."

Children are usually quick in distinguishing between their parent and his or her twin; but I have two cases to the contrary. Thus, the daughter of a twin says:

"Such was the marvellous similarity of their features, voice, manner, etc., that I remember, as a child, being very much puzzled, and I think, had my aunt lived much with us, I should have ended by thinking that I had two mothers."

In the other case, a father who was a twin, remarks of himself and his brother:

"We were extremely alike, and are so at this moment, so much so that our children up to five and six years old did not know us apart."

I have four or five instances of doubt during an engagement of marriage. Thus:

"A married first, but both twins met the lady together for the first time, and fell in love with her there and then. A managed to see her home and gain her affection, though B went sometimes courting in his place, and neither the lady nor her parents could tell which was which."

I have also a German letter, written in quaint terms, about twin brothers who married sisters but could not easily be distinguished by them.[1] In the well-known novel by Mr. Wilkie Collins of "Poor Miss Finch," the blind girl distinguishes the twin she loves by a touch of his hand, which gives her a thrill that the touch of the other brother does

[1] I take this opportunity of withdrawing an anecdote, happily of no great importance, published in "Men of Science," p. 14, about a man personating his twin brother for a joke at supper, and not being discovered by his wife. It was told me on good authority; but I have reason to doubt the fact, as the story is not known to the son of one of the twins. However, the twins in question were extraordinarily alike, and I have many anecdotes about them sent me by the latter gentleman.

not. Philosophers have not, I believe, as yet investigated the conditions of such thrills; but I have a case in which Miss Finch's test would have failed. Two persons, both friends of a certain twin lady, told me that she had frequently remarked to them that "kissing her twin sister was not like kissing her other sisters, but like kissing herself — her own hand, for example."

It would be an interesting experiment for twins who were closely alike to try how far dogs could distinguish them by scent.

I have a few anecdotes of strange mistakes made between twins in adult life. Thus, an officer writes:

"On one occasion when I returned from foreign service, my father turned to me and said, 'I thought you were in London,' thinking I was my brother — yet he had not seen me for nearly four years — our resemblance was so great."

The next and last anecdote I shall give is, perhaps, the most remarkable of those I have; it was sent me by the brother of the twins, who were in middle life at the time of its occurrence:

"A was again coming home from India, on leave; the ship did not arrive for some days after it was due; the twin brother B had come up from his quarters to receive A, and their old mother was very nervous. One morning A rushed in saying, 'Oh, mother, how are you?' Her answer was, 'No, B, it's a bad joke; you know how anxious I am!' and it was a little time before A could persuade her that he was the real man."

Enough has been said to prove that an extremely close personal resemblance frequently exists between twins of the same sex; and that, although resemblance usually diminishes as they grow into manhood and womanhood, some cases occur in which the diminution of resemblance is hardly perceptible. It must be borne in mind that it is not necessary to ascribe the divergence of development, when it occurs, to the effect of different nurtures, but it is quite possible that it may be due to the late appearance of qualities inherited at birth, though dormant, in early life, like gout. To this I shall recur.

There is a curious feature in the character of the resemblance between twins, which has been alluded to by a few correspondents; it is well illustrated by the following quotations. A mother of twins says:

"There seemed to be a sort of interchangeable likeness in expression, that often gave to each the effect of being more like his brother than himself."

Again, two twin brothers, writing to me, after analyzing their points of resemblance, which are close and numerous, and pointing out certain shades of difference, add:

"These seemed to have marked us through life, though for a while, when we were first separated, the one to go to business and the other to college, our respective characters were inverted; we both think that at that time we each ran into the character of the other. The proof of this consists in our own recollections, in our correspondence by letter, and in the views which we then took of matters in which we were interested."

In explanation of this apparent interchangeableness, we must recollect that no character is simple, and that in twins who strongly resemble each other, every expression in the one may be matched by a corresponding expression in the other, but it does not follow that the same expression should be the prevalent one in both cases. Now it is by their prevalent expressions that we should distinguish between the twins; consequently when one twin has temporarily the expression which is the prevalent one in his brother, he is apt to be mistaken for him. There are also cases where the development of the two twins is not strictly *pari passu;* they reach the same goal at the same time, but not by identical stages. Thus: A is born the larger, then B overtakes and surpasses A, and is in his turn overtaken by A, the end being that the twins, on reaching adult life, are of the same size. This process would aid in giving an interchangeable likeness at certain periods of their growth, and is undoubtedly due to nature more frequently than to nurture.

Among my thirty-five detailed cases of close similarity, there are no less than seven in which both twins suffered from some special ailment or had some exceptional peculiarity. One twin writes that she and her sister "have both the defect of not being able to come downstairs quickly, which, however, was not born with them, but came on at the age of twenty. Three pairs of twins have peculiarities in their fingers; in one case it consists in a slight congenital flexure of one of the joints of the little finger; it was inherited from a grandmother, but neither parents, nor brothers, nor sisters show the least trace of it. In another case the twins have a peculiar way of bending the fingers, and there was a faint tendency to the same peculiarity in the mother, but in her alone of all the family. In a third case, about which I made a few inquiries, which is given by Mr. Darwin, but is not included in my returns, there was no known family tendency to the peculiarity which was observed in the twins of having a crooked little finger. In another pair of twins, one was born ruptured, and the other became so at six months old. Two twins at the age of twenty-three were attacked by toothache, and the same tooth had to be extracted in each case. There are curious and close correspondences mentioned in the falling off of the hair. Two cases are mentioned of death from the same disease; one of which is very affecting. The outline of the story was that the twins were closely alike and singularly attached and had identical tastes; they both obtained Government clerkships, and kept house together, when one sickened and died of Bright's disease, and the other also sickened of the same disease and died seven months later.

Both twins were apt to sicken at the same time in no less than nine out of the thirty-five cases. Either their illnesses, to which I refer, were non-contagious, or, if contagious, the twins caught them simultaneously; they did not catch them the one from the other. This implies so intimate a constitutional resemblance, that it is proper to give some quotations in evidence. Thus, the father of two twins says:

"Their general health is closely alike; whenever one of them has an illness, the other invariably has the same within a day or two, and they

usually recover in the same order. Such has been the case with whooping-cough, chicken-pox, and measles; also with slight bilious attacks, which they have successively. Latterly they had a feverish attack at the same time."

Another parent of twins says:

"If anything ails one of them, identical symptoms *nearly always* appear in the other; this has been singularly visible in two instances during the last two months. Thus, when in London, one fell ill with a violent attack of dysentery, and within twenty-four hours the other had precisely the same symptoms."

A medical man writes of twins with whom he is well acquainted:

"Whilst I knew them, for a period of two years, there was not the slightest tendency towards a difference in body or mind; external influences seemed powerless to produce any dissimilarity."

The mother of two other twins, after describing how they were ill simultaneously up to the age of fifteen, adds that they shed their first milk-teeth within a few hours of each other.

Trousseau has a very remarkable case (in the chapter on Asthma) in his important work, "Clinique Médicale." (In the edition of 1873 it is in Vol. II, p. 473.) It was quoted at length in the original French, in Mr. Darwin's "Variation under Domestication," Vol. II, p. 252. The following is a translation:

"I attended twin brothers so extraordinarily alike, that it was impossible for me to tell which was which, without seeing them side by side. But their physical likeness extended still deeper, for they had, so to speak, a yet more remarkable pathological resemblance. Thus, one of them, whom I saw at the Néothermes at Paris, suffering from rheumatic ophthalmia, said to me, 'At this instant my brother must be having an ophthalmia like mine'; and, as I had exclaimed against such an assertion, he showed me a few days afterwards a letter just received by him from his brother, who was at that time at Vienna, and who expressed himself in these words—'I have my ophthalmia; you must be having yours.' However singular this story may appear, the fact is none the less exact; it has not been told to me by others, but I have seen it myself; and I have seen other analogous cases in my practice. These twins were also asthmatic, and asthmatic to a frightful degree. Though born in Marseilles, they were never able to stay in that town, where their business affairs required them to go, without having an attack. Still more strange, it was sufficient for them to get away only as far as Toulon in order to be cured of the attack caught at Marseilles. They travelled continually, and in all countries, on business affairs, and they remarked that certain localities were extremely hurtful to them, and that in others they were free from all asthmatic symptoms."

I do not like to pass over here a most dramatic tale in the "Psychologie Morbide" of Dr. J. Moreau (de Tours), Médecin de l'Hospice de Bicêtre. Paris, 1859, p. 172. He speaks "of two twins brothers who had been confined, on account of monomania, at Bicêtre":

"Physically the two young men are so nearly alike that the one is

easily mistaken for the other. Morally, their resemblance is no less complete, and is most remarkable in its details. Thus, their dominant ideas are absolutely the same. They both consider themselves subject to imaginary persecutions; the same enemies have sworn their destruction, and employ the same means to effect it. Both have hallucinations of hearing. They are both of them melancholy and morose; they never address a word to anybody, and will hardly answer the questions that others address to them. They always keep apart, and never communicate with one another. An extremely curious fact which has been frequently noted by the superintendents of their section of the hospital, and by myself, is this: From time to time, at very irregular intervals of two, three, and many months, without appreciable cause, and by the purely spontaneous effect of their illness, a very marked change takes place in the condition of the two brothers. Both of them, at the same time, and often on the same day, rouse themselves from their habitual stupor and prostration; they make the same complaints, and they come of their own accord to the physician, with an urgent request to be liberated. I have seen this strange thing occur, even when they were some miles apart, the one being at Bicêtre, and the other living at Saint-Anne."

I sent a copy of this passage to the principal authorities among the physicians to the insane in England, asking if they had ever witnessed any similar case. In reply, I have received three noteworthy instances, but none to be compared in their exact parallelism with that just given. The details of these three cases are painful, and it is not necessary to my general purpose that I should further allude to them.

There is another curious French case of insanity in twins, which was pointed out to me by Sir James Paget, described by Dr. Baume in the "Annales Médico-Psychologiques," 4 série, vol. I, 1863, p. 312, of which the following is an abstract. The original contains a few more details, but too long to quote: François and Martin, fifty years of age, worked as railroad contractors between Quimper and Châteaulin. Martin had twice slight attacks of insanity. On January 15 a box was robbed in which the twins had deposited their savings. On the night of January 23-24 both François (who lodged at Quimper) and Martin (who lived with his wife and children at St. Lorette, two leagues from Quimper) had the same dream at the same hour, three A.M., and both awoke with a violent start, calling out, "I have caught the thief! I have caught the thief! they are doing mischief to my brother!" They were both of them extremely agitated, and gave way to similar extravagances, dancing and leaping. Martin sprang on his grandchild, declaring that he was the thief, and would have strangled him had he not been prevented; he then became steadily worse, complained of violent pains in his head, went out of doors on some excuse, and tried to drown himself in the river Steir, but was forcibly stopped by his son, who had watched and followed him. He was then taken to an asylum by gendarmes, where he died in three hours. François, on his part, calmed down on the morning of the 24th, and employed the day in inquiring about the robbery. By a strange chance, he crossed his brother's path at the moment when the latter was

struggling with the gendarmes; then he himself became maddened, giving way to extravagant gestures and using incoherent language (similar to that of his brother). He then asked to be bled, which was done, and afterwards, declaring himself to be better, went out on the pretext of executing some commission, but really to drown himself in the river Steir, which he actually did, at the very spot where Martin had attempted to do the same thing a few hours previously.

The next point which I shall mention in illustration of the extremely close resemblance between certain twins is the similarity in the association of their ideas. No less than eleven out of the thirty-five cases testify to this. They make the same remarks on the same occasion, begin singing the same song at the same moment, and so on; or one would commence a sentence and the other would finish it. An observant friend graphically described to me the effect produced on her by two such twins whom she had met casually. She said: "Their teeth grew alike, they spoke alike and together, and said the same things, and seemed just like one person." One of the most curious anecdotes that I have received concerning this similarity of ideas was that one twin, A, who happened to be at a town in Scotland, bought a set of champagne glasses which caught his attention, as a surprise for his brother B; while, at the same time, B, being in England, bought a similar set of precisely the same pattern as a surprise for A. Other anecdotes of a like kind have reached me about these twins.

The last point to which I shall allude regards the tastes and dispositions of the thirty-five pairs of twins. In sixteen cases — that is, in nearly one-half of them — these were described as closely similar; in the remaining nineteen they were much alike, but subject to certain named differences. These differences belonged almost wholly to such groups of qualities as these: the one was the more vigorous, fearless, energetic; the other was gentle, clinging, timid; or the one was more ardent, the other more calm and placid; or again, the one was the more independent, original, and self-contained; the other the more generous, hasty, and vivacious. In short, the difference was that of intensity or energy in one or other of its protean forms; it did not extend more deeply into the structure of the characters. The more vivacious might be subdued by ill-health, until he assumed the character of the other; or the latter might be raised by excellent health to that of the former. The difference was in the key-note, not in the melody.

It follows from what has been said concerning the similar dispositions of the twins, the similarity in the associations of their ideas, of their special ailments and of their illness generally, that the resemblances are not superficial, but extremely intimate. I have only two cases of strong bodily resemblance being accompanied by mental diversity, and one case only of the converse kind. It must be remembered that the conditions which govern extreme likeness between twins are not the same as those between ordinary brothers and sisters, and that it would be incorrect to conclude from what has just been said about the twins that mental and bodily likeness are invariably coördinate, such being by no means the case.

We are now in a position to understand that the phrase "close similarity" is no exaggeration, and to realize the value of the evidence I am about to adduce. Here are thirty-five cases of twins who were "closely alike" in body and mind when they were young, and who have been reared exactly alike up to their early manhood and womanhood. Since then the conditions of their lives have changed. What change of nurture has produced the most variation?

It was with no little interest that I searched the records of the thirty-five cases for an answer; and they gave an answer that was not altogether direct, but it was distinct, and not at all what I had expected. They showed me that in some cases the resemblance of body and mind had continued unaltered up to old age, notwithstanding very different conditions of life; and they showed in the other cases that the parents ascribed such dissimilarity as there was, wholly or almost wholly, to some form of illness. In four cases it was scarlet fever; in a fifth, typhus; in a sixth, a slight effect was ascribed to a nervous fever; in a seventh it was the effect of an Indian climate; in an eighth, an illness (unnamed) of nine months' duration; in a ninth, varicose veins; in a tenth, a bad fracture of the leg, which prevented all active exercise afterwards; and there were three additional instances of undefined forms of ill-health. It will be sufficient to quote one of the returns; in this the father writes:

"At birth they were exactly alike, except that one was born with a bad varicose affection, the effect of which had been to prevent any violent exercise, such as dancing or running, and, as she has grown older, to make her more serious and thoughtful. Had it not been for this infirmity, I think the two would have been as exactly alike as it is possible for two women to be, both mentally and physically; even now they are constantly mistaken for one another."

In only a few cases is some allusion made to the dissimilarity being partly due to the combined action of many small influences, and in none of the thirty-five cases is it largely, much less wholly, ascribed to that cause. In not a single instance have I met with a word about the growing dissimilarity being due to the firm freewill of one or both of the twins, which had triumphed over natural tendencies; and yet a large proportion of my correspondents happen to be clergymen, whose bent of mind is opposed, as I feel assured from the tone of their letters, to a necessitarian view of life.

It has been remarked that a growing diversity between twins may be ascribed to the tardy development of naturally diverse qualities; but we have a right, upon the evidence I have received, to go farther than this. We have seen that a few twins retain their close resemblance through life; in other words, instances do exist of an apparently thorough similarity of nature, in which such difference of external circumstances as may be consistent with the ordinary conditions of the same social rank and country do not create dissimilarity. Positive evidence, such as this, cannot be outweighed by any amount of negative evidence. Therefore, in those cases where there is a growing diversity, and where no external cause can be assigned either by the twins themselves or by their family

for it, we may feel sure that it must be chiefly or altogether due to a want of thorough similarity in their nature. Nay, further, in some cases, it is distinctly affirmed that the growing dissimilarity can be accounted for in no other way. We may, therefore, broadly conclude that the only circumstance, within the range of those by which persons of similar conditions of life are affected, that is capable of producing a marked effect on the character of adults, is illness or some accident which causes physical infirmity. The twins who closely resembled each other in childhood and early youth, and were reared under not very dissimilar conditions, either grow unlike through the development of natural characteristics which had lain dormant at first, or else they continue their lives, keeping time like two watches, hardly to be thrown out of accord except by some physical jar. Nature is far stronger than Nurture within the limited range that I have been careful to assign to the latter.

The effect of illness, as shown by these replies, is great, and well deserves further consideration. It appears that the constitution of youth is not so elastic as we are apt to think, but that an attack, say of scarlet fever, leaves a permanent mark, easily to be measured by the present method of comparison. This recalls an impression made strongly on my mind several years ago, by the sight of some curves drawn by a mathematical friend. He took monthly measurements of the circumference of his children's heads during the first few years of their lives, and he laid down the successive measurements on the successive lines of a piece of ruled paper, by taking the edge of the paper as a base. He then joined the free ends of the lines, and so obtained a curve of growth. These curves had, on the whole, that regularity of sweep that might have been expected, but each of them showed occasional halts, like the landing-places on a long flight of stairs. The development had been arrested by something, and was not made up by after-growth. Now, on the same piece of paper, my friend had also registered the various infantine illnesses of the children, and corresponding to each illness was one of these halts. There remained no doubt in my mind that, if these illnesses had been warded off, the development of the children would have been increased by almost the precise amount lost in these halts. In other words, the disease had drawn largely on the capital, and not only on the income, of their constitutions. I hope these remarks may induce some men of science to repeat similar experiments on their children of the future. They may compress two years of a child's history on one side of a ruled half-sheet of foolscap paper, if they cause each successive line to stand for a successive month, beginning from the birth of the child; and if they economize space by laying, not the 0-inch division of the tape against the edge of the pages, but, say, the 10-inch division.

The steady and pitiless march of the hidden weaknesses in our constitutions, through illness to death, is painfully revealed by these histories of twins. We are too apt to look upon illness and death as capricious events, and there are some who ascribe them to the direct effect of supernatural interference, whereas the fact of the maladies of two twins being continually alike shows that illness and death are necessary

incidents in a regular sequence of constitutional changes beginning at birth, and upon which external circumstances have, on the whole, very small effect. In cases where the maladies of the twins are continually alike, the clocks of their two lives move regularly on at the same rate, governed by their internal mechanism. When the hands approach the hour, there are sudden clicks, followed by a whirring of wheels; the moment that they touch it, the strokes fall. Necessitarians may derive new arguments from the life histories of twins.

We will now consider the converse side of our subject, which appears to me even the more important of the two. Hitherto we have investigated cases where the similarity at first was close, but afterwards became less; now we will examine those in which there was great dissimilarity at first, and will see how far an identity of nurture in childhood and youth tended to assimilate them. As has been already mentioned, there is a large proportion of cases of sharply contrasted characteristics, both of body and mind, among twins. I have twenty such cases, given with much detail. It is a fact that extreme dissimilarity, such as existed between Esau and Jacob, is a no less marked peculiarity in twins of the same sex than extreme similarity. On this curious point, and on much else in the history of twins, I have many remarks to make, but this is not the place to make them.

The evidence given by the twenty cases above mentioned is absolutely accordant, so that the character of the whole may be exactly conveyed by a few quotations:

1. One parent says: "They have had *exactly the same nurture* from their birth up to the present time; they are both perfectly healthy and strong, yet they are otherwise as dissimilar as two boys could be, physically, mentally, and in their emotional nature."

2. "I can answer most decidedly that the twins have been perfectly dissimilar in character, habits, and likeness from the moment of their birth to the present time, though they were nursed by the same woman, went to school together, and were never separated till the age of fifteen."

3. "They have never been separated, never the least differently treated in food, clothing, or education; both teethed at the same time, both had measles, whooping-cough, and scarlatina at the same time, and neither had any other serious illness. Both are and have been exceedingly healthy and have good abilities, yet they differ as much from each other in mental cast as any of my family differ from another."

4. "Very dissimilar in body and mind; the one is quiet, retiring, and slow but sure; good-tempered, but disposed to be sulky when provoked; — the other is quick, vivacious, forward, acquiring easily and forgetting soon; quick-tempered and choleric, but quickly forgetting and forgiving. They have been educated together and never separated."

5. "They were never alike either in body or mind and their dissimilarity increases daily. The external influences have been identical; they have never been separated."

6. "The two sisters are very different in ability and disposition. The

one is retiring but firm and determined; she has no taste for music or drawing. The other is of an active, excitable temperament; she displays an unusual amount of quickness and talent, and is passionately fond of music and drawing. From infancy, they have been rarely separated even at school, and as children visiting their friends, they always went together."

7. "They have been treated exactly alike; both were brought up by hand; they have been under the same nurse and governess from their birth, and they are very fond of each other. Their increasing dissimilarity must be ascribed to a natural difference of mind and character, as there has been nothing in their treatment to account for it."

8. "They are as different as possible. (A minute and unsparing analysis of the characters of the two twins is given by their father, most instructive to read, but impossible to publish without the certainty of wounding the feelings of one of the twins, if these pages should chance to fall under his eyes.) They were brought up entirely by hand, that is, on cow's milk, and treated by one nurse in precisely the same manner."

9. "The home-training and influence were precisely the same, and therefore I consider the dissimilarity to be accounted for almost entirely by innate disposition and by causes over which we have no control."

10. "This case is, I should think, somewhat remarkable for dissimilarity in physique as well as for strong contrast in character. They have been unlike in body and mind throughout their lives. Both were reared in a country house, and both were at the same schools till *aet.* 16."

11. "Singularly unlike in body and mind from babyhood; in looks, dispositions, and tastes they are quite different. I think I may say the dissimilarity was innate, and developed more by time than circumstance."

12. "We were never in the least degree alike. I should say my sister's and my own character are diametrically opposed, and have been utterly different from our birth, though a very strong affection subsists between us."

13. The father remarks: "They were curiously different in body and mind from their birth."

14. The surviving twin (a senior wrangler of Cambridge) adds: "A fact struck all of our school contemporaries, that my brother and I were complementary, so to speak, in point of ability and disposition. He was contemplative, poetical, and literary to a remarkable degree, showing great power in that line. I was practical, mathematical, and linguistic. Between us we should have made a very decent sort of a man."

I could quote others just as strong as these, in some of which the above phrase "complementary" also appears, while I have not a single case in which my correspondents speak of originally dissimilar characters having become assimilated through identity of nurture. However, a somewhat exaggerated estimate of dissimilarity may be due to the tendency of relatives to dwell unconsciously on distinctive peculiarities, and to disregard the far more numerous points of likeness that would first attract the notice of a stranger. Thus in case 11, I find the remark, "Strangers see a strong likeness between them, but no one who knows them well can per-

ceive it." Instances are common of slight acquaintances mistaking members, and especially daughters of a family for one another, between whom intimate friends can barely discover a resemblance. Still, making reasonable allowance for unintentional exaggeration, the impression that all this evidence leaves on the mind is one of some wonder whether nurture can do anything at all, beyond giving instruction and professional training. It emphatically corroborates and goes far beyond the conclusions to which we had already been driven by the cases of similarity. In those, the causes of divergence began to act about the period of adult life, when the characters had become somewhat fixed; but here the causes conducive to assimilation began to act from the earliest moment of the existence of the twins, when the disposition was most pliant, and they were continuous until the period of adult life. There is no escape from the conclusion that nature prevails enormously over nurture when the differences of nurture do not exceed what is commonly to be found among persons of the same rank of society and in the same country. My fear is that my evidence may seem to prove too much, and be discredited on that account, as it appears contrary to all experience that nurture should go for so little. But experience is often fallacious in ascribing great effects to trifling circumstances. Many a person has amused himself with throwing bits of stick into a tiny brook and watching their progress; how they are arrested, first by one chance obstacle, then by another; and again, how their onward course is facilitated by a combination of circumstances. He might ascribe much importance to each of these events, and think how largely the destiny of the stick had been governed by a series of trifling accidents. Nevertheless all the sticks succeed in passing down the current, and in the long run, they travel at nearly the same rate. So it is with life, in respect to the several accidents which seem to have had a great effect upon our careers. The one element, that varies in different individuals, but is constant in each of them, is the natural tendency; it corresponds to the current of the stream, and inevitably asserts itself.

Much stress is laid on the persistence of moral impressions made in childhood, and the conclusion is drawn, that the effects of early teaching must be important in a corresponding degree. I acknowledge the fact, so far as has been explained in the chapter on Early Sentiments, but there is a considerable set-off on the other side. Those teachings that conform to the natural aptitudes of the child leave much more enduring marks than others. Now, both the teachings and the natural aptitudes of the child are usually derived from its parents. They are able to understand the ways of one another more intimately than is possible to persons not of the same blood, and the child instinctively assimilates the habits and ways of thought of its parents. Its disposition is "educated" by them, in the true sense of the word; that is to say, it is evoked, not formed by them. On these grounds I ascribe the persistence of many habits that date from early home education, to the peculiarities of the instructors rather than to the period when the instruction was given. The marks left on the memory by the instructions of a foster-mother are soon sponged clean away. Consider the history of the cuckoo, which is reared ex-

clusively by foster-mothers. It is probable that nearly every young cuckoo, during a series of many hundred generations, has been brought up in a family whose language is a chirp and a twitter. But the cuckoo cannot or will not adopt that language, or any other of the habits of the foster-parents. It leaves its birth-place as soon as it is able, and finds out its own kith and kin, and identifies itself henceforth with them. So utterly are its earliest instructions in an alien bird-language neglected, and so completely is its new education successful, that the note of the cuckoo tribe is singularly correct.

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A Journal Devoted to the Practical Problems of Elementary and Secondary Education and the Professional Training of Teachers


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## SYLLABI OF COURSES IN ELEMENTARY AND APPLIED PSYCHOLOGY


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TEACHERS COLLEGE RECORD

VOL. II SEPTEMBER, 1901 No. 4

# SYLLABI OF COURSES IN ELEMENTARY AND APPLIED PSYCHOLOGY

BY EDWARD L. THORNDIKE

Adjunct Professor of Genetic Psychology in Teachers College, Columbia University

(The courses described are subject to revision)

The purpose of this number of the RECORD is to give an account of the required courses in pure and applied psychology at the Teachers College. It comprises syllabi of two courses, the Elements of Psychology and the Applications of Psychology in Teaching. An outline of the course in Child Study (Education 9) was given in the RECORD for May, 1901 (Vol. II, No. 3), The two former are required of candidates for all diplomas, and together occupy three periods a week for a year. The course in Child Study is required of all candidates for the Elementary and Kindergarten Diplomas, and occupies two periods a week throughout the year. Normally, all three courses when taken by the same student are taken the same year.

These courses form the basis of the psychological side of the student's professional work, and are aimed to fit students for intelligent and efficient work as teachers. It is the policy of the department to give a thorough and scholarly introduction to the study of methods of teaching rather than a multitude of precepts and devices, or any cut-and-dried system of applied psychology. The superior training and mental calibre of college students should make them independent thinkers concerning methods of teaching throughout their professional careers, and

a good preparation for such thought will be better than any outfit of knowledge possibly presented in a single course. Moreover, these courses are followed by courses in general and special methods.

### ELEMENTARY PSYCHOLOGY (PSYCHOLOGY A)

Psychology A is a course in the scientific study of human nature and intelligence. It aims to preserve such breadth and rigor of treatment as fits a course for an academic degree and still to meet the peculiar wants of the prospective teacher. The latter end is attained by the selection of topics and by the use of illustrations from school life whenever possible. Semi-metaphysical questions, such as the nature of the self, the nature of knowledge, or the supra-phenomenal relation of mind and body, are entirely eliminated. Any detailed study of the physiology of the sense organs, of the relation of stimulus to sensation, or of the minute analysis of mental states into hypothetical elements, is dispensed with. Emphasis is laid upon the description of mental phenomena, an understanding of their neural basis, and especially upon mental life in function, upon mental states in action.

James' *Briefer Course* is used as a text-book, but a week is given at the beginning of the course to an introduction of the students to the general field of psychology by a simpler book, *The Human Nature Club,* and some topics in the course involve required readings in James' *Principles of Psychology.* The study of the texts is supplemented by class discussions and some additional topics are presented by the instructor.

#### SYLLABUS OF THE COURSE

1. The Aim of Psychology and the Nature of its Subject Matter. Thorndike: *Human Nature Club,* pp. 1-137.

2. The Common Technical Terms. (Presented by class discussions.)

> States of consciousness — sensations — percepts — mental imagery—memories—associations of ideas—individual notions—general notions—abstractions—feelings of relationship —judgments—impulses—emotions—æsthetic emotions.

3. The Physiological Basis of Mental Life. James: *Briefer Course,* p. 5, last paragraph to middle of p. 6. Lecture and demonstration.

Nerve cells—their function—nerves—afferent and efferent nerves—relex arc—localization of brain functions—associative fibres—inhibitory action—adaptability of the nervous system—law of habit as the general law of brain action.

4. Characteristics of Mental Life in General. James: *Briefer Course,* pp. 152-175, omitting last paragraph on 161 and 166 to middle of 167.

5. The Function of Mental Life. (Presented in class discussion.)

6. Unlearned Reactions or Instincts. James: *Principles of Psychology,* II., 383-402.

Nervous basis—growth into habits—inhibition of by disuse, by accompanying discomfort or substitution—variation in.

7. Learned Reactions. Ways of Learning. (Lecture and discussion.)

By selection of chance successes—by imitation—by ideas—factors involved in the last.

8. Sensations. James: *Briefer Course,* pp. 9 to middle of 17, 24-27.

Nature of—nervous basis—differences in—quality—intensity—range—delicacy of discrimination—defects—function.

9. Percepts. James: *Briefer Course,* pp. 312-326, 329-339.

Nature of—nervous basis—due to natural selection—illusions—hallucinations—factors involved in perception—the psychology of reading as an example of perception.

10. Apperception. *Human Nature Club,* pp. 57-64; James: *Briefer Course,* pp. 326-329.

Influence of general make-up of the mind—of particular spheres of thought—of what temporarily possesses the mind—nervous basis.

11. Attention. James: *Briefer Course,* pp. 217-237.

Nature—classification—nervous basis—function—feeling of effort in attention—qualities that secure attention—results of attention.

12. Imagery and Memories. James: *Briefer Course,* pp. 302-311, 287-301.

Types of—nervous basis—reproductive and productive—laws of memory—conditions of a good memory—improvement of memory.

13. The Order of our Thoughts. James: *Briefer Course,* pp. 253-279.

(A) Spontaneous and (B) controlled associations—classification of (A)—laws of—characteristics of (B)—relation to (A)—qualities of the efficient thinker.

14. Discrimination. James: *Briefer Course,* pp. 244-252.

Nature of—vagueness of primitive perceptions and ideas—conditions of discrimination of parts within wholes—of discrimination between objects or ideas—training in discrimination.

15. Reasoning. James: *Briefer Course,* pp. 239-243, 351-367.

Psychological factors of—feelings of relationship—feelings of meaning, individual, general, abstract—judgments—inferences—qualities of a good thinker—association by focal recall—comparison—selection.

16. Induction and Deduction.

The meanings of terms—logical aspect—psychological aspect—psychological factors and the validity of inductions and deductions—psychology of sources of error in.

17. The Emotions. James: *Briefer Course,* pp. 374-390.

Causation of—evidence—classification—genesis—function—æsthetic emotions.

18. Purposive Action. James: *Briefer Course,* pp. 415-455.

Conduct in terms of movement—classification of acts—instinctive acts—ways of modifying them. Purposive movements are secondary performances—ideo-motor action—association of movements with ideas, impulses, etc.—attention and purposive action—the feeling of effort—its significance. Theories of motives—types of action and decision—diseases of the will.

19. Automatic Action and Habit. James: *Briefer Course,* pp. 134-150.

Phenomena—causation—connection with purposive action—function—practical significance.

20. Suggestion.

Phenomena of—relation to ideo-motor action—analysis of.

21. The General Laws of Mental Action. Lecture.

22. Mental Training. *Human Nature Club,* pp. 170-180. Lecture.

At the end of the course a series of afternoon lectures are given presenting the results of special studies or dealing with general psychological questions not treated in the course. Attendance upon these lectures is voluntary. Their topics have been such as the following:

The Psychology of Temperament.
Mental Fatigue.
The Psychology of Interest.
Inheritance of Mental Traits.
Psychology and Philosophy.
The Mental Traits of Animals.
The Evolution of the Human Intellect.
The Mathematical Aspect of Psychology.
The Correlation of Mental Abilities.

## SUPPLEMENTARY NOTES

As a means of rendering permanent the results of those of the class discussions which supplement the text and of aiding students to comprehend the relationships of topics, typewritten notes on the various topics are from time to time given to the class. For 1900-1901 they were as follows:

2. The Common Technical Terms.

Psychology is the science which deals with *states* of *consciousness,* e. g., dreams, reveries, pleasures, pains, aches, emotions, memories, thoughts, sights, tastes, etc. Its business is to tell us

(1) what our thoughts and feelings are,

(2) how they come to be what they are,

(3) what causes make a person have certain thoughts and feelings rather than others,

(4) how our thoughts and feelings influence our bodily activities.

NOTE. Difference between feelings of things and things themselves. Explain by facts of dreams, hallucinations, different feelings caused in different people by same thing.

Our first duty is to familiarize ourselves with some of the facts, the phenomena, the data which we are to study and with the names given to these facts in books about psychology.

Touch yourself with a pencil.
Bend your finger.
Prick yourself with a pin.
Listen to the tap of a stick on the floor.

The feelings you have are called by psychologists *sensations*.

Look at a picture.
Listen to a melody.
Take hold of something with your eyes shut.

You feel in each case the feeling of some *thing* which is there. We call these feelings *percepts* or *perceptions*.

Imagine to yourself the tune of Yankee Doodle.
Imagine to yourself the feeling of velvet.
Imagine to yourself the sight of the Dewey Arch.
Imagine to yourself that your arm is swinging back and forth.

The feelings you have we call *mental imagery* or *mental images*. A mental image we may call the feeling of a thing or a sensation when it is really not there and is known not to be there.

Think what you were doing yesterday at one o'clock. Recall the feeling you have when you meet some one whom at first you don't remember but finally remember as having been with you at a certain place.

These feelings are what James calls "memory proper."

A child is asked, "What is the Latin for 'he loves'?" and replies, "Amat." Repeat to yourself any poetry that you know. You see a man and think of his name.

These feelings are cases of "associations of ideas," but are commonly called cases of memory.

We often also use the words memory and remember and forget for habits or matters of skill that are permanent. We remember how to dance, swim, play the piano, etc. Finally, we often call any mental image a *memory*.

If we have such thoughts as,

"Eggs are nutritious,"
"Girls are better than boys,"
"Electricity is not a fluid."
"All teachers should be paid,"
"Dewey is a hero,"

there may be images of sight, sound, etc., in connection with the thoughts, but they vary with different people, and are not the important thing in the thought. The important thing is the feeling of our *meaning*. Thus in the fourth thought, we feel that we mean *all* teachers, though we may have an

image of some one teacher, or of the sound of the word teacher, or of something different. These feelings of *meaning* are very important in all our higher sorts of thinking. When the feeling is that we mean every one of a class of things (e. g., "all teachers," or "girls") we call the feeling a *general notion* or *concept*. When we feel that we mean one particular thing (e. g., when we think "Napoleon," etc., or "this apple," etc.,) we call the feeling an *individual notion*.

We feel not only sensations, objects, meanings, but also the relations between them. For instance, if we look at two books, one of which is bigger than the other, we feel not only percepts of the books but also their relation of inequality. When we feel "cats *and* dogs" we not only have two general notions, but also the feelings that they are to be taken together. Very important among such feelings of relationship are those of likeness and difference. Try to observe in yourself the feelings you have when you think of *or, nevertheless, above, below, like, unlike, equal, unequal, the same as.*

The whole feelings we had in thinking the sentences given to show *meanings,* are called *judgments*. They are feelings of "is-ness" (to coin a word), feelings that may be expressed in declarative sentences.

Later on, a careful analysis will be made of our feelings of *meanings* and *relationships,* and of our *judgments.*

Put a small piece of blotting paper wet with acid on your forehead. Besides the sensations arising, you have a feeling which ordinarily would lead you to raise the hand to remove it; you feel, that is, a certain *impulse.* Recall the feelings which go with or just before coughing, yawning, raising your arm, etc.

When you next feel them, watch your feelings of indecision before acting, of decision, of desire, of bodily effort, of mental effort. See just how you feel when you do something, or think of doing it, when you "choose," when you "try."

When you next feel any one of the states commonly called joy, grief, anger, fear, hope, sympathy, try to see just what it feels like.

Watch your feelings (apart from the mere seeing, hearing, etc.) when looking at a beautiful picture, reading a novel, watching a play, hearing music. We call such feelings *aesthetic emotions.*

## 3. The Physiological Basis of Mental Life.

So far we have tried to get before us specimens of different sorts of mental facts and to acquaint ourselves with the names used for them by psychology. We have now to get a notion (a very rough and incomplete one) of the physiological or bodily facts which condition these mental facts.

Mental states, as we know them, depend upon brain-states. Different things happening in the nervous system or parts of it go with the different thoughts and feelings we have.

What, then, is the nervous system and what happens in it? The ner-

vous system is the sum total of nerve cells. Its action is the action of these nerve cells.

Recall demonstration of photographs and drawings of nerve cells.

Recall explanation of nerve cells as machines to conduct impulses or carry currents. Does the conduction run along smoothly or by a series of explosions?

A nerve is a bundle of long processes from a number of cells.

Recall the explanation of "*afferent*" and "*efferent*" nerves.
Recall the explanation of "*reflex arc.*"
Recall the explanation of "*localization of brain functions.*"
Recall the explanation of "*associative fibres.*"
Recall the explanation of "*inhibitory action.*"

## 4. Characteristics of Mental Life in General.

We have seen specimens of mental facts and obtained a rudimentary notion of what goes on in the brain. We shall now notice some general characteristics of all mental facts by reading pp. 152-175, omitting from p. 153 "*Every one will recognize*" to line 4 of p. 154, p. 161, second paragraph to p. 162, 12th. line, p. 166, 12th. line to middle of 167.

It is also convenient to think of mental states as,

(1) *attended to* or *not* (focal or marginal),
(2) *desirable* or *undesirable,*
(3) *clear* or *hazy,*
(4) *intense* or *weak.*

Give examples of mental states contrasting in these respects.

## 5. The Function of Mental Life.

We have now to see what mental states are for, what their business is in connection with human life in general, in scientific terms, what their function is.

We can best look on human life as a series of *reactions* to *situations,* a series which lasts as long as life lasts. By the word *situation* we express the fact that something happens to us and by the word *reaction* the fact that something happens in us or that we do something. Thus our stomachs react to the situation "pieces of food present" by pouring forth digestive fluids; our throat muscles react to the situation "something tasting good in the mouth" by swallowing; thus the baby reacts to the situation "sight of bright red paper" by grasping at it; thus the boy reacts to the situation "sound of a band playing" by running toward it; thus the pupil reacts to the teacher's words by taking notes. Now it is clear that our mental states influence very many of our reactions. One who has the mental state "memory that Jefferson was the third president" will react in one way to the question, "Who were the first three presidents?" One who has no such mental state will react differently (Give other examples.)

This is what mental states are for, to influence our bodily reactions to the situations or outward circumstances or environments in which we find ourselves. We found that the brain was a machine which provided

responses of the body to stimuli from outside. Consciousness, mental states go with the activity of parts of this machine and so mediate between situation and reaction.

We shall have to use the words situation and reaction very freely. Sometimes we shall mean the physical situation, sometimes the mental or psychological or felt situation. Thus let two persons be in the presence of a sound. The physical situation is air vibrating and is alike for both. The *felt* situation may be different according as one is asleep or awake, deaf or not, attentive or not. And there may be a mental or felt situation with no outside physical situation as its basis. E. g., The mental image of the motto "Don't worry" may cause one to relax his muscles and attention. The word reaction may mean the physical reaction, which will always be a movement of bone, muscle, glands, cells, etc., or it may mean a mental reaction; e. g., the presence of an idea of George Washington following upon the situation "hearing the words, 'First in war, first in peace,' etc."

Our main business will be to study the mental stuff composing and the conditions influencing the *felt* situations and the mental reactions, though we shall also have to know something about the physical reactions.

Now the process from situation to reaction is continuous, and it is only for convenience in description and discussion that we separate them. We really could not mark any point in the whole process, for instance, which takes place in the outer world and nervous system when we hear the cry "Fire" and run, and say, "This part was situation, this part was reaction, this part was mediation between them." Nor can we mark any point where the felt situation ceases and mental elaboration begins, or where mental elaboration ceases and mental reaction begins. The same mental stuff may be considered situation from one point of view and reaction from another; e. g., you hear a newsboy cry, "Horrible railway accident!" think of your brother who is travelling, feel anxiety, have the idea of buying the paper and do so. Your thought of your brother is your reaction to the sounds you hear, but serves also as part of the situation which brings the reaction "feeling of anxiety"; the latter again is also part of the situation bringing the reaction "thought of buying the paper."

## 6 and 7. Unlearned Reactions or Instincts. Methods of Learning.

Our reactions to most situations are the results of experience. We have learned what is the thing to do. But some reactions to some situations are made without any learning, are made because of the inherited structure of our nervous systems.

We shall call all these unlearned reactions, instincts, though it has been customary to call those which took place without consciousness reflex actions.

Examples are:

Situation: "being alone in the dark." Reaction: fear.

Situation: "feet on ground plus impulse to get somewhere." Reaction: walking.

Most of the things which we do we did not know how to do instinctively; we had to *learn* to do them. We learn to do things by

(1) *Trial and accidental success.*

Here our inherited make-up leads us to make in a certain situation a number of acts. If one of them brings satisfaction it is stamped in in connection with that situation so that it is more and more likely to be done. The acts which bring discomfort are stamped out. Recall the chick learning the way out of the pen, the baby learning to grab the bottle, the boy learning to fight.

The method is evidently one of selection of one act from many by reason of its success. The selection may be from not only instinctive acts but also acts previously learned.

(2) *Imitation.*

Here the sight of an act of another leads us to perform the act.

(2) may be combined with (1): e. g., in learning to pronounce a language.

(3) *Having ideas about the thing.*

In (1) and (2) there need be no definite ideas influencing our behavior at all. But in the majority of cases of human behavior we do things because we hear or see or remember or imagine or suppose or reason out something. E. g., Why did you come to Teachers College? Why does the boy say 500 when asked, "How much is 20 times 25?" Such reactions due to the presence of ideas are the chief possession of human beings as contrasted with the lower animals; a complete explanation of them requires us to study a number of different sorts of mental facts.

When we ask, "What mental factors determine our conduct in cases where we have learned to do things by thinking about them?", we find that they are chiefly our

previous experiences,
sensations and percepts,
attention,
images and memories,
feelings of meaning, judgments and reasonings.

All of these factors must therefore be studied.

## 8. Sensations.

The felt situations to which we react depend in the first place on our sensations. All our knowledge (and much of our activity) starts from sensations. We have already become acquainted with the bare facts, sensations. We have now to notice a few things about them. For lists of the different sorts of sensations, see Titchener, Outlines of Psychology, pp. 49-51.

It is clear that sensations differ one from another. Complexes of sensations (e. g., the sights of two different neckties, the sounds of two different chords), differ because they are made up of different elements. Elementary sensations have (1) differences corresponding to differences in the end-organs concerned: e. g., hunger vs. red, cold vs. sounds, pressures vs. tastes. There are also (2) differences of quality between sensations from the same sense: e. g., red vs. green, note C vs. note E. There are also (3) peculiar qualititive differences (which seem differences of more or less of a certain thing) which we call differences of *intensity:* e. g., bright vs. dim light, a loud vs. a soft note. Further differences we cannot take time to discuss in this course, but see Titchener 52-75.

The limits high and low to the number of air vibrations, ether vibrations, etc., which cause sensations vary with different people and different circumstances: e. g., old people in general do not hear some very high notes which young people in general do hear. The distance between these limits is called the *range* of sensations for any person at any time.

Not all differences in the physical stimuli are felt as differences in sensations. A certain amount of difference has to be reached before any difference is *felt.* (Recall class experiments.) Further, the same amount of difference, which, when added to one stimulus, causes a feeling of the difference, may not cause such feeling when added to a stronger stimulus: e. g., two lines 16 inches and 16 1-8 inches will not be felt to differ, though two lines 1-4 and 3-8 inches in the same circumstances will. Ability to notice correctly differences between sensations is called *sense-discrimination.*

## 9. Percepts.

Recall examples and definitions from earlier lessons. James should furnish answers to the questions:

(1) What is the brain-action which goes with perception?
(2) What determines what "thing" shall be felt when certain sensation-processes are present?
(3) What is an illusion? What brain-action goes with such a feeling?
(4) What are some different types of illusions?
(5) Are the mistakes in our illusions due to bad action of the senses or bad interpretation?
(6) What is the difference between sensations and percepts?
(7) Is the feeling of a thing made up of a lot of feelings of its different parts?
(8) What are the causes of illusions?

Although our felt situations depend for their constitution on sense powers, yet what we feel is generally not mere color or sound or taste, but rather things, objects. The nervous process caused by the activity of a sense-organ arouses in the brain (which has had previous experiences of a similar nature) connected processes, and both together give rise to the

"feeling of a thing" which we call a percept. Percepts are thus very important factors in our situations, and the felt situation depends on them as well as on the senses. Recall demonstration in class of different things being felt from just the same sense stimulation.

An illusion is the feeling of a thing when it is *not* there, but something else is, which we mistake for it.

An hallucination is the feeling of a thing when it is *not* there and nothing else is.

There is no hard and fast line between percept, illusion and hallucination; every percept is partly illusion. The process in each case is the same; the difference is in the way it is caused. Ordinary perception (e. g., hearing a conversation or reading a book) is a mixture of percept and illusion.

## 10. Apperception.

We have seen that the felt situations and the reactions to them depend on the sensations and percepts aroused, that therefore the condition of the sense-organs is an important factor. But the feelings aroused do not depend entirely on the stimulus given, but also on the condition of the mind which reacts to it.

(1) Recall cases where the different previous experiences of two or more people make differences in the way they feel the same stimulus: e. g., a musician and an ordinary person at a concert.

(2) Recall cases where the different present thoughts of people make differences in the feelings they have at the same stimulus.

It may be the general condition of the mind, or it may be only the condition of some particular sphere of consciousness which is thus influential. Thus (to give an instance of the latter) the reaction a person makes to the words "Fermez la porte," is uninfluenced by the presence or absence of experiences of lions, or knowledge of Greek, or the belief in ghosts, but is decidedly dependent on the presence or absence of a knowledge of French.

This general fact that the effect of any stimulus depends on what mental content is already present has been called "apperception" by pedagogical theorists. The particular systems of ideas, spheres of consciousness, contents concerned have been called "apperceptive masses." In common-sense English the fact is that what we think and feel and do at any time depends on what we *have* thought and felt and done in the past. The real reason for it we saw when studying the nervous system. It was that the nervous system was a machine which was changed by everything that happened to it and by everything it did.

## 11. Attention.

We have seen how our felt situations are conditioned by the condition of our sense-organs, our powers of discrimination and our whole mental make-up and previous experiences. They are further conditioned by the degree to which they are focal in consciousness. A person may have

good ears and a knowledge of the French language, but unless he is attending to you, your words "Fermez la fenêtre" will not influence him. One of the most important differences in our feelings is between those attended to and those not. Recall examples.

James' chapter should answer for you:

(1) Are our feelings always either focal or marginal or may we have at one time all the objects of our thoughts equally prominent?
(2) What are some cases nearly in the latter state?
(3) In what different ways would you classify attention?
(4) Explain each classification: i. e., tell in each case just what are the differences between the different sorts of attention. See pp. 221-225. In *Principles,* 416-424.
(5) How do we ordinarily attend during an hour's hard study?
(6) What happens in the brain when we attend?
(7) What are our reasons for believing that these events (mentioned in the answer to the last question) happen? pp. 229-236 are all on this point. In *Principles,* pp. 434-446.

Think up examples of every fact you read about in this chapter.

Some results of attention are that situations which are attended to are more likely to be assimilated, discriminated, remembered, understood.

Some qualities in a stimulus or situation which gain immediate attention are

(1) Intensity,
(2) Clearness,
(3) Novelty (but with
(4) sufficient *familiarity* to be assimilated),
(5) Pleasurableness, and
(6) Expectation on the part of the person.

It will pay to think of examples from school life or elsewhere of attention gained by reason of each of these qualities, and of failure to gain attention due to their absence. Think also how far it is wise to use each of these qualities.

*Inattention* may be due either to

(a) attention to something else,
(b) general scatterbrainedness.

## 12. Imagery and Memories.

Examine some of your own images of sounds, tastes, movements, sights, etc.

Pages 302-310, *Principles;* II, 50-68, are descriptions of these various sorts of imagery.

Pages 310-311, *Principles;* II, 68-75, give an account of the brain processes which may be supposed to cause them, viz:—

(1) Nerve action in a special part of the brain, or
(2) Nerve action in the same part of the brain as was concerned in the real experience, but of a less intense sort, or
(3) Nerve action in the same part plus differing associated action.

Remember that such images are commonly called memories.

PRODUCTIVE IMAGINATION

What is the difference between it and the foregoing?
How are such images caused?

MEMORY

Just what does James mean by memory? See p. 287-288. *Principles* 648-652.
What are the causes of any such memory feeling? See p. 289-292. *Principles* 653-659.
What then makes a person likely to remember successfully?
(Note that here James is thinking of associative memory as well as personal memory).
How far can one improve one's memory?

## 13. The Order of Our Thoughts.

### A. SPONTANEOUS THINKING

James tries to answer three main questions, viz:

(1) What determines the order of our thoughts?
(2) How shall the different sorts of association be classified?
(3) Supposing an obect to have been associated with several others, which of them will it call up?

He answers (1) on pages 256-258. *Principles* 552-557, 561-569. Recall also what was said about accident (see p. 278) and sense-impressions.

He answers (2) by classifying associations according to how much of the first thought is at work in calling up the second. We have thus:

(a) total recall, pp. 259-261. *Principles* 569-571.
(b) partial recall, pp. 261-263. *Principles* 571-574.
(c) focalized recall, pp. 267-269. *Principles* 578-580.

He answers (3) on pp. 264-267. *Principles* 574-577. It will call up, he says, the one which is its

most recent associate,
most vivid associate,
most habitual associate,
most congruous associate.

We might add that it will, other things being equal, call up an idea that belongs to the same mental system. One's mental life is really a

complex of a lot of different lives or systems or attitudes: e. g., one's school system of thoughts, one's home system, one's system with one's intimates, one's society system. When one's mind is, so to speak, tuned to one of these ways of thinking, any idea that comes up will be likely to call up some idea that accords with that system. Recall and think of illustrations.

Some other questions answered in this chapter are:

(1) What element in any object will count most, be most prepotent in calling to mind other objects? See pp. 262-263. *Principles* p. 572.

(2) Does being similar cause ideas to be associated? See p. 268, last half. *Principles* p. 579.

(3) What really happens when we have a so-called association by similarity?

### B. Voluntary Thinking

Voluntary thinking is spontaneous thinking plus the selection of the ideas which fit. The good thinker is, then, the one (1) whose mind is fertile, has many ideas, (2) who sees which fit and picks those out, and (3) keeps his attention on them, paying no regard to non-essentials.

## 14. Discrimination.

James' chapter on Discrimination should answer for you the following questions:

What facts do we mean by the word "discrimination"?

Do we naturally feel a complex thing as a complex of various elements or characteristics or as a vague whole?

How do we come to feel the differences between any two things or situations? i. e., What conditions have to be fulfilled in order that we may feel their difference?

Just how does each one of these conditions work? pp. 245-248. In *Principles,* 494-502.

How do we come to feel the elements of a complex thing? 248-251. In *Principles* 502-508.

How do we perfect our powers of discrimination?

## 15. Reasoning.

We have now to study the feelings which we have when we understand things, reason about them, think concerning them. The study of logic tells us how we think when we think rightly; psychology tells how we think whether we think rightly or wrongly, understand or misunderstand.

At the beginning of the course we noticed as common mental facts (1) feelings of meaning or reference, (2) of judgments. These are the important feelings concerned in comprehension. Very many of our sen-

sations and percepts and images and memories are turned at once into judgments: e. g., a note is struck on the piano and we feel not the bare sound but rather the thought or judgment, "I hear the note C on a piano." We look at a line and an image of the word "straight" comes to our mind, but is turned at once into a judgment, "That line is straight," etc., etc.

James' chapter on Conception tells about our feelings of the meaning or reference of our thoughts; the chapter on Reasoning tells how our judgments combine to make "reasonings" and what the essentials of successful reasoning are.

In particular the chapter on Conception tells us:

(1) That we can refer to or mean the same thing though the mental states involved be different. (Illustrate.)

(2) That we can mean

(a) a class of objects (concept, universal, general notion),

(b) a particular object (individual notion),

(c) an abstract quality (abstraction),

(d) a thing which doesn't even exist.

Each of these sorts of meanings is important in different sorts of thinking: e. g., mass, velocity, acceleration, etc., in physics are abstractions; line, angle, circle in geometry are universals; Cæsar, Cicero, Washington, New York, the Mississippi River are particulars; the fourth dimension, lines of infinite length, a machine to turn the potential energy of coal directly into electrical energy, are "problematic objects."

In the chapter on Reasoning, James tells us:

(1) That the mere course of our ideas following the laws of association often brings us to correct results: e. g., we thus know that night will follow to-day;

(2) but that we often think out problems which we have never met before and couldn't answer by mere association: e. g., how to bridge the East River.

(3) We do this:

(a) By being able to think the *elements,* or *properties,* or *facts about* the situation confronting us;

(b) by being able to think of the consequences of those facts. Illustrate these two powers.

What names does James give to these two abilities?

(4) To reason successfully then we must be able to *pick out* the element or characteristic or fact about the situation which it will be useful to know in the particular case we are dealing with. We must also be able to *compare* things, to catch vital, important similarities so that we can tell something about a thing from our knowledge of things like it. *Selection* and *comparison* are good names for these two sorts of thinking.

James should also help you to answer the questions:

(1) Why is association by similarity generally frequent in good reasoners?

(2) Are there any properties or elements which are the real, true being of a thing (e. g., of a potato), which are *the* essentials of a potato?

Tell just what happens when a person thinks thus:

This man has a broken neck, therefore he will die.

## 17. The Emotions.

Read again pp. 370-372.

Certain objects, circumstances and ideas do cause in us emotional feelings. They also clearly cause certain conditions or affections of our bodies, particularly of our internal organs or viscera and of our circulatory system.

The James-Lange theory of the emotions says that at least in large measure they *are* the *feelings of these bodily conditions.* Just as we see when our retinas are stimulated, so we feel fear, joy, jealousy, etc., when the sensory nerves coming from our hearts, stomach, chest, etc., etc., are stimulated by various conditions of those organs. See pp. 375-376. *Principles* 442-451.

### The Evidence.

(1) There may be such conditions or affections of the bodily organs before the emotional feeling comes. See pp. 376-377. *Principles* p. 457.

(2) Such conditions are felt and if we attend to our emotions we can resolve them at least partly into definite bodily feelings. p. 378. *Principles* 451.

(3) If we do so resolve the emotion into such components and then imagine it without them, it is no longer emotional. p. 379-380. *Principles* 451-453.

If such be the causes of our emotions it is foolish to try to classify them. For they will vary indefinitely. p. 381; p. 374. *Principles* 453-454.

For the source and growth or the genesis of our emotions, see pp. 386-390. *Principles* 477-485.

## 18. Purposive Action.

Our first question is: "How do we come to make the movements that we do?"

If we examine the following list of acts (each due of course to movements, contractions of some muscles) we see that they fall into groups as shown by the figures:

1. Swallowing
2. walking
3. writing

1.2. laughing

3. playing tennis

1.2. crying

3. putting on one's hat

2. reaching for things

1. breathing
1. sneezing
1. the knee jerk
1. blushing

3. talking.

We have classified them roughly according to the way that we come to perform them.

(1) Acts like those numbered 1 we can perform in general (a) without having had to gradually acquire them, (b) without any act of volition: i. e., without definitely willing to do them. Further they are (c) not easily modifiable: i. e., we cannot easily change or abolish them. The name "reflexes" applies roughly to such acts. They are in short (1) unlearned, (2) involuntary, (3) not easily modifiable.

(2) Acts like those numbered 2 are also unlearned and may happen apart from any attention to do them, but they are modifiable, may be inhibited or confirmed. The name instinctive acts applies roughly to them, but there is no hard and fast line between acts of the (1) and (2) classes.

(3) Acts like those numbered 3 differ from (1) and (2) in being acquired by experience, learned and being primarily voluntary, intended, willed acts, though they may become automatic.

For an account of acts of the (1) group, see any standard physiology.

For an account of acts of the (2) group, see James, pp. 391-400. *Principles* 383-385, 403-441.

The important questions are:

Why do we do these things without having to learn them?
How do we modify them?

e. g., By confirming such impulses by habit.
By inhibiting such impulses by painful consequences.
By inhibiting such impulses by other contradictory impulses.
By inhibiting such impulses by forming the habit of dealing with a situation in some other way.
By losing them by mere failure to exercise them.

Recall examples of instincts modified in each one of these ways.

For an account of acts of the (3) group, see pp. 415-428, and the following notes. *Principles* 486-493 and 518-530.

We have found that our nervous systems are so organized as a result of heredity that we make certain movements in certain situations without intending or deciding to make them, without foreseeing them or their consequences. Let us remember too that we make some random movements by accident, because of accidental changes in the activity of the nervous system. It is also possible that we are so organized that we tend to make certain movements when we see them made, that is, to act at times from mere imitation. All this without any foreseeing or intending: i. e., without willing.

Only movements thus made without volition, can later be made as a result of will. See James 415-416. *Principles* 487-488.

How does this control by the will come about?

The impulse to any movement made is associated with a number of ideas. The impulse to a movement comes in connection with sights, sounds, thoughts of all sorts; the movement itself brings feelings of movement in the part moved, of its position, of the things it may touch, of its appearance to the eye, etc. It also results in more indirect consequences: e. g., we write a, b, c, and feel not only such sensations as have been just described but also the sight of the letters on the paper.

Impulses and consequently movements thus become associates of certain ideas and may be called up just as other ideas are, by the ordinary laws of association. We can then control these movements because we can control our ideas. We get a movement by bringing up some idea which leads to it, and our feeling of intending or willing to do a thing is our feeling of having such an idea, attending to it and allowing it to prevail and result in its appropriate movement. This is the gist of 417-428.

James defends and explains this view by saying:

(1) We need not have any feeling of "innervation," of how much nervous discharge there is. pp. 418-419.

(2) The feeling of "let it occur," "fiat," is alike in all sorts of movements willed, (419) and

(3) This "fiat," decision, determination, willing is not necessarily present. The mere thought of a movement tends of itself to bring the movement to pass. pp. 423-428. *Principles* 522-528.

(4) Our control over our movements is then not over them directly, but over them by means of our control of the ideas which serve as "motor-cues," and this control occurs by means of attention. p. 448-449. *Principles,* from bottom of 559 to top of 565. (Read very carefully).

(5) Our feeling of effort when we determine or decide or will to do something is not a feeling of some peculiar thing, "the will," doing something, but is the same feeling of effort that we get when we voluntarily attend to any idea. In this case the idea is an idea which leads to a movement and so we commonly call the effort "an effort of will" or a feeling of the exercise of our will power. It is, however, just the feeling which goes with attention. 450-455. *Principles* 565-567.

(6) Obstacles, oppositions which prevent our willing a certain thing, are then just oppositions which prevent our attending solely to a certain idea and letting it possess us.

### The Philosophy of the Will

James says (pp. 458-460 and 455-458, *Principles* 569-579), that we feel as if we really were not wholly the result of heredity and circumstances, but really counted in the world, really made a difference, and that this is the highest of our accomplishments, the most serious thing in our life. It seems as if we could have attended otherwise than we did.

But, he adds, psychological science can prove neither this nor the opposite theory, and for ordinary purposes it is better to assume, as we all in fact do, that people's actions are controlled by causes and vary with their inherited traits, education, etc.: i. e., are not the result of unknown principles.

One theory has been that all our acts were caused by actual or imagined pleasurable or painful consequences. On p. 444-448 (*Principles* 549-559) James argues against this view by showing:

(1) That those of our acts which we call expressions of emotion are not so caused;

(2) that many habitual acts are not;

(3) that we often act directly contrary to the dictates of pleasure because an idea somehow possesses us.

### Types of Will

When we will something deliberately we generally have a feeling of indecision followed by one of decision.

On pp. 428-429 James tells what these feelings are really made up of. He then, pp. 429-434 (*Principles* 531-535) describes some different types of decision.

The healthy-minded person decides promptly after thinking over the proper associations, and has to reinforce abstract, ideal considerations, in order to counterbalance the force of instinctive preference, pleasure and pain, or habit. See pp. 435-436. *Principles* p. 536.

An unhealthy will may be shown in:

(1) Deciding without thinking over the situation, or

(2) misplaced inhibition, or

(3) misplaced impulsion.

If we have not enough inhibition, see 437-439, we may act too readily. So also if we have too much impulsion toward some particular acts. See 439-440. Both things result in the so-called "explosive will." The "obstructed will," due to too much inhibition or too little impulsion, is described on pp. 441-442. In the *Principles,* see pp. 537-549.

## APPLICATIONS OF PSYCHOLOGY IN TEACHING (EDUCATION 3)

The aim of this course is not so much to teach students applied psychology, as to teach them to apply psychology. It seeks to establish in them the habit of using knowledge of the facts of mental life to guide their thought about teaching and of applying general principles of method to particular problems in school life with intelligent caution and with constant appreciation of the limiting conditions of class-room work. To insure that the students themselves realize the derivation of precepts of method from facts of psychology, this part of the course consists in great measure of questions to be answered by each student independently on the basis of the previous work of the class. These answers are discussed, compared and explained in the recitation periods. Two systematic text-books of method are also studied. In order that students shall keep before their minds the actual conditions of class-room instruction and the actual nature of a teacher's work and so make their work in the course relevant to real needs, they are required to spend twenty hours in the school, to make a collection of material which they think would be helpful in school work, to examine and criticize lessons chosen from various text-books, to make out plans for lessons, study hours, home work and excursions, and to answer a variety of practical questions taken from actual school life. Inasmuch as personality is the chief factor in class management, a part of the course will deal with the means of cultivating those personal traits which determine a teacher's efficiency.

The outline that follows includes a list of the topics of the course with references to the previous readings in psychology, samples of the questions set the students and brief summaries of the additional discussions, and a description of the practical work required.

One section of the class in Education 3 is composed entirely of prospective teachers of fine arts, manual training, and domestic

art and science. This section will substitute for parts of the work here described a study of those applications of the psychology of sensation, movement and æsthetics to teaching which are especially relevant to their professional needs. Their practical work in observation, study and construction of lesson plans, etc., will also be differentiated from that of the other sections.

## SYLLABUS OF THE COURSE

1. General Introduction. *Talks to Teachers,* pp. 3-14, 22-32; *Human Nature Club,* pp. 42-46. *Syllabus,* pp. 8 and 9.

If we describe the fact of life as a series of physical and mental reactions to various situations, how should we describe the work of the teacher? Do the reactions which children make to what they see and hear and read come by accident or caprice, or do they follow regular laws? Is good teaching a matter of luck or guess-work or miracle, or a thing that can be understood and controlled? What are the differences between the reactions which children make to what happens to them and the reactions of iron to the magnet, a metal to an acid, the stomach to food?

What are some of the important limiting conditions to children's reactions which are due to the customary organization of schools? Which would be easier to bring about, some desired reaction in one boy or in twenty-five children in a grade? Why?

Would you expect Psychology to furnish a set of definite rules for teaching particular subjects to particular children? Would you expect that you could find in it knowledge that would turn you from a bad to a good teacher? Would you expect that it might suggest changes in your ways of teaching that you could then test by actual trial; that it would prepare you to observe the actual workings of children's minds so as to get an unconscious appreciation of how to influence them? What else would aid you?

> Teaching defined in psychological terms—the application of psychology to it—limitations of such application—individual differences—hereditary capacities—subtle personal traits in the teacher—their cultivation.

2. Plan of Work.

What are the factors that cause our reactions to our surroundings? Suppose you wished to apply what could be known about these factors from psychology to the problems concerning

their use in school work, in what order would you take them up? Pick out three or four of the most important for school work. Which ones does James discuss (in his "Talks to Teachers")? Fitch? McMurry? (Look at table of contents in each case.)

3. Means of Receiving Stimuli and Reacting to Them. *Human Nature Club,* pp. 10-15.

Can you teach anything to a child who has no sense organs? Name three common sense defects in school children. What measures would you take to make your teaching effective in spite of each of these defects? Would the mere knowledge of the existence of the defect help your teaching if you did nothing about it? Do you think that the voice that you ordinarily use in class discussions is suitable to class teaching? What simple precepts about teacher's work do you derive from the fact that to react to a stimulus, children must see or hear or feel it?

By means of what apparatus does a child react to his environment? Is this apparatus alike in all children? In the same child at all ages? What features of school work depend largely upon it?

4. General Mental Functions. *Human Nature Club,* Chapters II and III. *Syllabus,* pp. 9 and 10.

Do we have to teach children everything they learn? Do we have to cultivate in them all the interests they come to possess? Can we direct their attention as we will? How do the facts on which you base your answers to these questions limit the teacher's influence? How may they be made to assist it?

Recall the facts concerning the three chief processes of learning: by the selection of chance successes, by imitation, and by gaining ideas. If in learning to write legibly the child improves by the gradual strengthening of those impulses which give him pleasure and by the weakening of those which give him discomfort, the teacher should naturally seek to make the child feel pleased when he writes well, and uncomfortable when he writes badly. Which is oftenest done? Which is the more efficacious? Which is better, to praise or rebuke the child for his writing at the end of a period, or at the very moment he is writing? Why does mere repetition of itself fail to make one improve? What is necessary in order that it shall be profitable to "try, try again"? Do teachers ever err in trying to teach by explanation what can be learned only by the selection of successes? Give instances. Give

instances of other mistakes due to trying to have children learn in one way what can only be learned in one of the others.

Name a number of things learned in school by imitation. What obvious precepts would you derive concerning the teacher's voice, accent, dress, handwriting, nervous mannerisms? What other important features in the teacher's make-up are likely to be imitated? Has the psychology of imitation any bearing on problems of discipline?

What are the chief factors involved in learning by ideas? In applying your knowledge about them to problems of teaching, what order would you follow? Why?

5. Apperception. *Human Nature Club,* Chapter V; *Syllabus,* p. 12; *Notes on Child Study,* Section 8.

If the effect of any stimulus depends not only upon its nature but also on the condition of the minds that receive it, we must evidently fit our teaching to the children we teach. Nothing can be taught them until they have a mental content that can assimilate it. How would you allow for this fact in planning a course of study? In planning a lesson? How would this fact help to explain the advantages of a regular teacher over a substitute? Would it offer any evidence that time spent in review would often be saved later? What difference would there be between two teachers of history, one of whom at each lesson retraced certain features of the last lessons, the other of whom began by making some statement in advance? Which features should be thus retraced, if any? Should this always be done in every lesson? Should the teacher always make sure that her statements will be understood and appreciated at the time she makes them? What would you take to be the meaning of this: "Each lesson or series of lessons should be an apperceptive whole"? From the point of view of this discussion, what might be the value of telling the class, at the beginning of a lesson, what you were going to try to teach them?

6. Attention. *Briefer Course,* pp. 217-236; *Notes on Child Study,* Section 9.

Bearing in mind what qualities in stimuli attract immediate attention, what precepts would you derive concerning the presentation of facts to children in text-books, lectures, recitations, etc.? Do you see why the newspapers use caricatures so much? Why

might it be bad teaching to have one regular plan for teaching a subject? Why would the liking of pupils for a teacher make them attend better? How might a pleasant schoolroom make pupils more attentive to their teacher? How might it make them less so? Is there any foundation in the psychology of attention for the belief that the aim of the work he is doing should be present in the mind of the scholar? What special devices have you seen used to gain and hold immediate attention?

Attention to certain things involves inattention to others. Distracting objects and events and occupations must naturally be avoided. How might the teacher herself serve to distract attention from what she is trying to teach?

Is there such a thing as general inattention, attention to nothing?

When we cannot get attention to stimuli because of their own intrinsic attractiveness, we must derive it from some external motive. What are some of the common motives used? Which of them do you consider the best? Which do you consider quite unjustifiable? Do you see any danger in appealing to children's liking for you to gain their attention to something intrinsically unattractive; in rewarding them with prizes, favors, etc.? Should a teacher expect the same motive to influence all those in her class? How can a teacher use tact and judgment in the motives to which she appeals?

The general question of what motives to use in leading children to do mental work will come up under "Incentives and Deterrents."

> Nature of attention—results—means of attaining—samples of their proper and improper use—summary of class discussion.

7. The Association of Ideas.

> The basis of purposive thinking—types of individuals in regard to—forgotten knowledge may still influence—relation to apperception—questioning as a means of calling up proper associations—misuse of questioning—mistakes due to vague associations—to the wrong element of the first idea being prepotent.

8. Comprehension, Reasoning, Logical and Abstract Thinking. *Briefer Course,* pp. 239-243, 351-367; *Human Nature Club,* pp. 108-110; *Syllabus,* pp. 15 and 16; *Notes on Child Study,* Section 13.

When any desired reaction depends upon feelings of the meanings of terms or propositions, we say commonly that the scholar must not only sense the stimulus and attend to it and have previous experience enabling him to assimilate it, but must also comprehend it or understand it or reason it out or see through it. In such cases (1) general notions, or notions of classes of objects and (2) general judgments, or judgments about classes of objects and (3) abstract ideas and (4) judgments concerning abstract qualities are very frequently present.

The appreciation of these, like the appreciation of sensations or percepts, is due in part to suitable previous experience. The existence of suitable mental content is one essential of the comprehension of rational trains of thought, and our discussion of apperception should therefore be borne in mind here. But people of similar previous experiences and present knowledge may differ in their powers to reason or understand abstract or general statements. Other processes then are involved.

Most thinkers about applied psychology have regarded only two of the simpler processes involved in reasoning things out, induction and deduction. By induction is meant the process of arriving at some general idea, or idea of a class of things, by the consideration of a number of individual things, or the process of arriving at some general judgment, or judgment about a class of facts, by the consideration of a number of individual facts. Thus the boy who considers an oak, an elm, a birch, etc., comes to have an idea of a tree in general. Thus the scholar who considers the action of sulphuric, hydrochloric and nitric acids, etc., on zinc, lead, and sodium, etc., arrives at the general judgment that acids dissolve metals. We take individuals that represent a class, notice something about them, and then affirm it of the class to which they belong. The validity of the process depends, of course, upon the representative quality of the individual facts we consider.

Corresponding to this process we have so-called inductive methods. What would be an inductive method of teaching a class to understand the meaning of "noun" and "verb"; that four threes make twelve; of teaching French or Latin; of teaching that the three angles of a triangle are equal to two right angles; that $-9$ times $-3$ gave $+27$? Is all comprehensible knowledge the result of induction?

Inductive methods of teaching will be discussed later in the course.

By deduction is meant the process of arriving at some judgment concerning a thing by virtue of knowledge concerning the properties of the general class to which it belongs. Thus a boy who knew of a word only that it was a noun could judge that it could be the subject of a sentence, could have adjectives for modifiers, etc., etc. Induction is often described as going from particular facts to general, deduction as going from general facts to particulars.

What would be a deductive method of teaching French or Latin? What grammar school subjects involve most deductive reasoning? What high school subjects?

Good teaching by inductive methods depends upon a clear statement of the goal aimed at, the selection of enough and representative individual facts, their arrangement in such a way as to make the general idea or judgment they lead to obvious, and the reinforcement and clarification of the general idea or judgment, when obtained, by applying it to new individual facts.

Good teaching by deductive methods depends upon a clear statement of the goal aimed at, independent search by pupils for the proper class under which to think of the thing in question, criticism by them and by the teacher of the different classes suggested, and appreciation of the reasons why the right one is the right one.

The psychology of the processes, other than correct induction and deduction, on which the accurate feelings of meanings and judgments and adroit inferences that constitute comprehension depend, is not well worked out, and we can only apply certain rather vague principles. Could a person reason well or follow intelligently a train of reasoning about a class of objects if his knowledge of the individual members of the class were imperfect? Could a person comprehend statements about a quality, say bivalence, if he did not know the essentials of that quality? Would he comprehend the answer to a question better if he were first made to realize the question? Why? If the habit of comparing things and the ability to see the essential elements in a thing and ready knowledge of the properties of these elements are the characteristics of the good reasoner, what sort of teaching would make students reason well? In which case would a student be the more likely to comprehend a theory or argument, if he had his knowledge in the form of images, for instance of a leaf of certain

shape, or if he had it in the form of a judgment that the leaf was of that shape? Would any of the qualities efficacious in gaining attention be also efficacious in gaining comprehension? If an adequate general notion, e. g., of a verb, requires that the essential similarities of the different individual things referred to be appreciated, should one example or many be given with the definition? If all judgments refer eventually to real objects, will it be generally safe to trust that judgments can be comprehended without actual demonstrations, experiments and objects lessons?

> **Mental factors involved in rational thought—induction —precepts concerning—deduction—precepts concerning—importance of data in reasoning—value of feeling questions to be answered—comparison—precepts concerning—selection—precepts concerning—clearness and arrangement—precepts concerning.**

The processes by which people think things out often cannot be followed at all. To some people the right idea simply comes, they know not whence or how. We say that such possess tact or scientific insight or instinctive business ability or what not, but we cannot give their rationale.

To all outside appearances such people simply guess, but they guess right. The essential element is picked out automatically. The idea that comes without any rational procedure is still the one that fits the situation. If you defined this general feeling for the truth of things as the power to guess right, how would you try to cultivate it in a scholar? Do teachers customarily encourage children to guess? When has any one a right to guess?

Read James: *Talks to Teachers,* pp. 33-37.

We have already seen that knowledge in the form of definite judgments is superior to knowledge in the form of hazy images, that recalling ideas from within is better than repeatedly receiving them from outside, that we test and increase our comprehension of a matter by applying it ourselves. All these things point to the fact that the expression of our ideas clarifies and renders permanent our knowledge. Moreover, knowledge is eventually of value only as expressed. Why? What other means of expression should the teacher secure besides words? How may examinations be made useful means of expression

on the part of pupils? Can a pupil express his feelings by silence?

> Summary of class discussion—possibilities in means of expression hitherto unused—need of economy of time in their use—danger of triviality—of absorption in technique—of relying on mythical influences of expression on thought.

If feelings of relationship are important elements in good thinking, if comparison is one of the chief features of rational, purposive thinking, if the associations or connections between ideas are in part the means and basis of thought, what ought the teacher to do besides arouse proper ideas? Are there any important relationships between subjects? Is it enough for a teacher of arithmetic to know arithmetic well?

> Related knowledge in teacher—in pupil—cross-references—systematic means of comparison—applications in different subjects.

9. Memory. *Briefer Course,* pp. 287-301.

In order to be fruitful, what we teach must not only be attended to, appreciated and understood, but also be made the pupil's permanent property. No apology is needed for the teacher who gives much thought to the best ways of aiding her scholars to remember. This is especially true if we bear in mind that memory is a wider function than mere verbatim knowledge, and includes permanent appreciation of the meanings of terms, of general facts and tendencies and laws. There are three common ways of memorizing, by repetition, concentration and recall. Which is the one commonly used by children? Which is the one commonly advocated by teachers? Which is the best? Why? Ebbinghaus found that it took sixteen repetitions to learn a series of twelve nonsense syllables, and fifty-five repetitions to learn a series of twenty-six. What suggestion would you get from this concerning memorizing poems, model sentences, quotations, etc.? Miss Aiken found that a poem could be best learned by learning a skeleton of the leading words, verbs, etc. What suggestion would you get from this concerning learning about a period in history or a topic in geography? Pupils often can recite a multiplication table glibly, and yet be slow and inaccurate in answering any one question, e. g., how much is 7 times 9; they often can conjugate a Latin verb through

glibly, and yet fail to translate readily any given form. What suggestion would you get from this concerning the nature of the associations to be formed in learning tables, grammatical forms, and such things? How would you apply the same facts to learning spelling? The secret of remembering things is having them associated firmly with those things in connection with which they will later be wanted. How would a systematic arrangement of subject-matter help pupils to remember it? How would cross-references help? In learning lists, the order of points of a discourse, etc., arbitrary devices of associating the different elements with other things are often helpful. Which ones have you ever used?

Summary of class discussion—criticism of mnemonic devices.

10. Imagery. *Briefer Course,* pp. 302-311; *Human Nature Club,* pp. 100-108.

The images which come up in memory may be more or less complete, faithful and lively. They are of different types, visual, auditory, etc. It has been said that one main duty of the teacher of history, geography, or literature is to make sure that pupils acquire and retain complete, faithful and vivid mental pictures of what has been described to them, that they can see, for instance, the Mississippi Valley or the advancing armies at Gettysburg spread out before their mind's eye. If the aim of the teaching is to produce in them the right reactions in the form of correct appreciations of general laws and tendencies and correct judgments, and if what James says on pages 169-170 is true, how would you criticise the view just stated?

The danger is that in pupils real appreciation of concrete things, no matter by what sort of images, will be replaced by mere memory of words or by only vague hints. We can prevent this by keeping our teaching close to reality. Would this mean that objects are always better than pictures, photographs than drawings, pictures than verbal descriptions? When we do have to resort to verbal description, useful images and true realization of the facts described will of course depend on all the factors that make a graphic style. One rule we may get from psychology. This rule will appear if we note which of the words in the following sets are the more graphic: $H_2O$ and water;

bootlicker and sycophant; reniform, kidney-shaped and bean-shaped. State the rule. From this point of view, what are the qualities of good similes and illustrations?

Supposed importance of types of imagery among children—value of work in composition to teacher—of collections of descriptive material.

So far we have sought light from psychology upon ways to secure knowledge and intellectual habits and powers on the part of pupils. What other great departments of mental life are there besides the intellect? Does the teacher need to know about them? If you think so, name any features of school work where you think knowledge about them would be useful.

11. The Emotions. *Briefer Course,* pp. 375-376; *Human Nature Club,* Chapter X.

If we accept the James-Lange theory of the emotions, what bodily attitude should we try to assume before our classes? What position should we aim to secure from children to help them in attending to a recitation? If we regarded nervousness as a crying evil among American children, what type of gait, manner of doing manual work and general style of movements should we encourage? Recall page 23 and think whether example or precept would be the better method to use in changing gait, etc.

12. The Active Side of Mental Life. *Briefer Course,* pp. 415-450; *Human Nature Club,* Chapter XI.

Teaching should aim to develop (1) the rational type of decision and (2) the power of deciding against sensuous, temporary, and personal in favor of abstract, lasting and unselfish motives. If the essential of the rational type of will is to wait till all necessary considerations are weighed, how might you encourage it in pupils? How did the old-time Puritan training develop (2)? Can you see a basis for the opinion of many people that the old rigorous and often unmeaning school training was superior to modern methods of making all school work appeal to the children's sense of what is worth while? How would you compromise between the need of training children to act from a mere "I will" in spite of discomfort and lack of personal motive and the need of interest and zest?

Would a boy learn to choose wisely if all his choices were made for him? Would he work more zealously if he were doing something he had himself chosen to do? Would he be likely to make that choice again if it turned out badly and he suffered?

Do teachers ever confuse what is really wrong with what annoys them? Does good behavior mean what is best for the boy and the school, or what is handy for the teacher? Classify common school offenses as (1) acts really dangerous to the pupil's welfare, and (2) acts unsuitable to school conditions. How should your attitudes to the two classes differ?

13. Habits. *Briefer Course,* pp. 134-150.

Make a list of the habits which school life should form in pupils; of habits in pupils which often have to be broken. How far is it true to say that everything can become to some extent an automatic habit? What is the advantage of establishing habits? What rules does James give concerning forming habits? Why would it be easier to teach a child to stop scowling by teaching him to smile rather than simply not to scowl? How would you modify the statement "Practice makes perfect" (see page 23)? Do you see any objection to asking a child to repeat when you think he has made a mistake; to letting children do the first five or ten examples under some new principle as a home task?

14. Suggestion. *Human Nature Club,* Chapter XIII; *Notes on Child Study,* pp. 110-118.

From your knowledge of ideo-motor action and suggestion, draw precepts concerning the utility of rebuking children for faults, forbidding them to do or be so and so, discussing their failings; concerning the advisability (1) of insisting that they do every bit of a piece of work, (2) of taking for granted obedience, faithfulness and successful work. State any adroit use of suggestion in teaching which you have witnessed, any common devices of handling children which depend upon suggestion. Is there any danger in enticing children into good behavior and right thoughts by suggestion instead of baldly demanding what is right? How may a teacher be misled into accepting as the result of the pupil's memory or judgment an answer which she has unconsciously suggested? Is this a common thing?

Successful use of suggestion partly a result of personality and direct experience—auto-suggestion as an explanation of self-confidence in teacher and pupil.

15. Interests.

Desired reactions of pupil include not only actual knowledge, mental ability and good conduct, but also permanent interests in attaining all these. Acquired interests grow out of instinctive—importance of interests in mental activity, ownership, emulation—interests follow knowledge and power —follow personal profit—due to infection from the teacher—interests not inconsistent with difficulty and dislike—practical precepts.

16. Mental Training.

Meaning of mental powers and mental training—special vs. general training—general training due to selection of elements common to different fields—to the selection of functions themselves of general utility—to the acquisition of ideas applicable throughout wider fields—danger of overconfidence in the value of disciplinary work—importance of showing pupils the applications of any idea or habit or power in other spheres than that in connection with which it was acquired—the great disciplinary lessons of the grade school work—samples of teaching fit to realize them.

17. Incentives and Deterrents.

So far we have in general discussed teaching as if it were a matter of indifference to the pupil whether he learned or not. But scholars who wish to learn will learn with a poor teacher or even none, and a teacher, no matter how skilful in other matters, who fails to inspire pupils with that desire will fall short of complete success. We have not only to supply a class with good opportunities but also with motives to make use of them. We have therefore to discuss incentives and deterrents or, more narrowly, rewards and punishments.

What would be an incentive to work intrinsic in the subject itself? Can we be sure that the work we think it well for children to do will be intrinsically attractive to them? What are some incentives outside the work itself? What are the incentives and deterrents commonly used by teachers? Do teachers tend to use any incentive that gets the work done? Would this ever be justifiable? Why do children so often fail to continue after they graduate the intellectual and moral activities begun in

school? What sort of incentives might change this? Why is it illogical to give extra lessons as a punishment for violation of school rules? For what would they be a logical punishment? We might agree that a rational system of incentives and deterrents would be one using those which the best people feel and give toward the different acts in question in the real world outside schools. What would be samples of such? Why would such a system tend to make school habits extend through life? Make a list of incentives and deterrents which you regard as suitable. State what sort of children each would fit best.

18. The Application of the Fundamental Law of Mind.

What is the most general law of mental life? Write a short essay or outline applying this law to the work of teaching. Consider it especially in connection with habits of attention? with apperception, the basis of rational thinking, correlation, voluntary action and habit. Lecture on same topic by instructor.

During and after the preceding work in applying psychological principles, the students spend six or more hours observing teaching in the Horace Mann School. In this observation they seek to enforce and enliven the habits of thought and the opinions they have gained by noticing actual examples. Incidentally the work familiarizes them with school life, gives them an appreciation of the personal elements that result in good teaching, and prepares them for their further work in observation, criticism and imitation of teaching in later courses. So far as possible, the observations will be made in groups of not over six students. The normal progress of the class work will be observed.

Each student is required to present a note-book containing observations illustrating the facts of the course so far, and questions suggested by the class work seen. These notes are discussed in class and returned with criticisms.

Besides applying their knowledge by actual observation, the class will make a study of ten or more lessons from text-books, some of which are printed in the following pages as samples. They will note good and bad points in these, and justify their decisions.

1. A section from a reader in geography designed for boys and girls from eleven to fourteen years old.

*A Reader in Physical Geography,* by R. E. Dodge, pp. 4-7

OUR RELATION TO THE WORLD AS A WHOLE.—The world as a whole is made up of land, water, and air; and of these the great bodies of land are the most important to us, for we live *on* and travel *over* the land, and get from it either directly or indirectly, nearly all of those materials that furnish us food, clothing and shelter...the three things that we must have in order to live. It is true that there are places in the world where men may go beneath the surface of the earth a very slight distance, in mines or in railway tunnels; but their stay as a usual thing is very short. The longest railway tunnel can be passed through in a few minutes and most miners have their homes on the surface of the earth, though they may stay several hours a day underground. Hence we can truthfully say that the vast majority of men live on the very surface of the land, and have but little to do with any other part of it. Indeed, we may almost say that man has never descended into the earth* a distance far enough to be thought of as being below the surface at all, for the deepest mine only penetrates the earth about a mile, and it is about four thousand miles to the centre of the earth.

In the same way, we have but little to do with other than the surfaces of the rivers, lakes and oceans of the world. We sail over the water of the ocean and large rivers and lakes with almost equal ease in any direction, and except in the case of deep-sea fishing, men are but little concerned in their daily life with any other parts of the waters of the world than the ever moving and ever changing surface.

When we think of the air, however, it is far different; for we live at the bottom of the atmosphere, and are related to it very much as a fish in the deep sea is related to the waters of the ocean. Occasionally men do rise into the air for a short distance in balloons, but they have not learned how to travel through the air or how to live in it, except at the bottom. The most hazardous voyages in balloons have carried men but little farther above the earth than mines go into it, and even birds that leave the solid earth, and remain poised above our heads for hours at a time, can reach but a limited height; they, like people and animals, who stay on the ground, are really at the bottom of the great ocean of air that stretches above the world for an unknown distance.

Beneath the oceans, as well as beneath the continents, are the solid rocks of the earth, that form the central core of the world—the foundation on which all else rests. This arrangement is just what we would

* The word *earth* is sometimes used to refer to the whole globe on which we live, and sometimes to the solid or rock part of that globe. It will be used in the latter sense here, and *world* will be used when we refer to the whole globe.

expect; for the solid earth is at the bottom, the liquid water is next above, and the invisible, gaseous atmosphere is over all, the three great parts of the world being thus arranged in the order of their weight. Yet these three divisions of the world are not absolutely separated, for the rocks and soils of the surface of the earth contain a great quantity of water, which, creeping along underground, feeds the roots of plants. Whenever this water appears at the surface, we have a wet place or a spring, from which water may trickle in a small stream. Every such spring or wet place is one of the beginnings of a large river; but it takes many, indeed hundreds of thousands, of such small springs to make a large river such as the Mississippi.

It is not, however, near the surface of the earth alone that water occurs in the rocks. Indeed, the deeper we go into the earth, the more water there seems to be, as any miner can tell you; for in some cases the water runs into mines so fast that large pumps have to be used night and day to keep the mine from filling. The holes and cracks in the rocks of the earth that are not full of water are full of air, so that we may say that on the land the earth, air, and water are thoroughly mingled.

In the same way we find a mingling of air and earth in the waters of the oceans, rivers, and lakes. The rock material in the water is easily seen, for most rivers, particularly after rain, are much discolored from the mud they contain. Indeed, the cleanest rain water of the heaviest storm contains rock material dissolved, as sugar may be dissolved in water that seems clear, and there is no water absolutely free from rock impurities except that which has been artificially purified in some chemical laboratory or large factory.

Passing from the water and earth to the air, we find again a mingling of materials similar to that which we have seen before. The air contains a great deal of water, which is at times invisible, but at other times perfectly visible as mist or fog. During storms some of this water or moisture falls to the earth, and runs down the slopes, making rivers that flow toward the oceans. Even after a heavy storm lasting several days, there is still a large amount of moisture left in the air, varying with the day and the part of the world. The air may be clear, apparently; but anything that absorbs moisture easily, like the wool on the back of a sheep, will feel damp to the touch, showing that moisture is present. The air in the eastern United States is most free from moisture during a clear, cold snap in winter, when the stars twinkle, and everything seems to crackle with dryness.

The particles of rock dust of a windy March day, and the dancing rays of the sunbeams as they stream across a room in a narrow path, tell us that there is rock material as well as moisture in the air. It is the dust in the air which catches the rays of light at sunset and gives us much of the beautiful color that we associate with that hour of the day. Thus we see that the three great divisions of the world we have mentioned are anything but independent and separate; indeed, the mingling is so complete that it is hard to deal with one of the three divisions without considering the others at the same time.

2. The first two pages of a general text-book on geography designed for schools and academies.

*Geography Made Easy,* pp. 1 and 2

DEFINITIONS

Geography is a Science which describes the figure, motion, magnitude, and component parts of the earth; the situations, extent and appearances of the various parts of its surface; its productions, animal and vegetable; its natural and political divisions; and the history, manners, customs, and religion of its inhabitants.

The Science which treats of the heavenly bodies, and explains their motions, magnitudes, periods, and distances is called *Astronomy.*

These two sciences are so intimately connected, that a competent knowledge of Geography is unattainable, without some previous acquaintance with Astronomy.

We shall commence this work with the following brief historical account of the origin, progress, and improvement of Geography and Astronomy.

HISTORY OF GEOGRAPHY AND ASTRONOMY

Geography, like every other science, at its beginning was very imperfect, and arrived at its present improved, though far from perfect state, by slow advances. The early geographers, being destitute of mathematical instruments, and unable to make astronomical observations began first to determine the situation of places according to climates, which they fixed from the form and color of the people and animals which were to be found in those different countries. The appearance of negroes, and of the large animals, such as the rhinoceros, and the elephant, suggested to them where to fix the limits of the torrid or burning zone. For reason, said they, points out to us, that similar animals and plants appear in the same temperature of the elements, and are produced according to the similar state of the air or climate under the same parallels, or a like situation equally distant from either pole. This was the first rude outline of Geography.

The Babylonians and Egyptians soon after adopted the method of determining the situations of places, or their distance from the equator, by observing the length of their longest and shortest day, which they determined by means of a kind of sun-dial, called a gnomon. All the places, for instance, where the longest day was just fourteen hours, or where the shortest day was ten hours, were, of course, at the same distance from the equator.

Astronomy, as a science, was first cultivated by the Egyptians, Phenicians, and Chaldeans. From them the Greeks derived their knowledge of this science.

The first of the Greeks, who laid the foundations of Astronomy, was Thales, born at Miletus, 641 years before Christ. He explained the

cause of eclipses, and predicted one. He taught that the earth was round, which before had been considered as an extensive plain, while the sun and stars moved round it. He divided the earth into five zones, discovered the solstices and equinoxes, and divided the year into 365 days. He travelled into Egypt, in quest of knowledge, and measured the height of the pyramids.

Pythagoras, the scholar of Thales, taught publicly the doctrine, common in his time, that the earth was the centre of the universe; but to his scholars, he communicated his real opinions, which were similar to those since adopted by Copernicus; that the earth and all the planets move round the sun as their centre; which doctrine he is supposed to have derived from the astronomers of India.

Philolaus, the scholar of Pythagoras, and Archytas of Tarentum, according to a passage in the works of Cicero, first taught publicly the diurnal or daily motion of the earth, and its annual or yearly motion round the sun. This passage is said to have suggested to Copernicus the first idea of that system which he established.

Democritus was the first who taught that the milky way is occasioned by the confused light of an infinity of stars, which is the doctrine still maintained by the best of philosophers. Plato and Aristotle and Eudoxus, the scholars of Plato, contributed much to the improvement of Astronomy.

3. The lesson on Paraguay from a general geography designed for the later grades of the grammar school.

*New School Geography,* pp. 246-247

PARAGUAY

Questions on map No. 28, Paraguay.—Bound Paraguay. What river on the east and south, on the west, flows through the centre? What mountains in the north? Where is Grand Island? What and where is the capital? Where is Concepción? Curuguaty? Villa Rica? Military Colony? Has Paraguay any sea-coast?

1. Position and Extent.—Paraguay lies south and west of Brazil, and is included principally between the Paraná and Vermejo Rivers. Greatest length, about 650 miles; breadth, about 400. Area, 190,000 sq. miles,—nearly equal to that of the State of California.

2. Natural Features.—Mountains.—A range of the Brazilian mountains extends through the eastern part. On each side of the mountains are fertile plains, upon which horses and cattle roam in great numbers. The Gran Chaco, mainly a desert region, lies west of the Paraguay River.

3. Soil and Climate.—The soil is very fertile. The climate varies according to elevation as one passes from the lower country to the mountains. In general it is mild and healthy.

4. Rivers.—The Paraguay and Paraná are the principal rivers. On

the Paraná River are several magnificent waterfalls; one stretch of a hundred miles is a continuous series of rapids.

5. Products.—The vegetable products of Paraguay are of great variety, and include many valuable woods and gums. Hides are largely exported. Yerba Mate (mah-tay), or Paraguay tea, is used instead of the tea of China. The animals and minerals are like those of the adjacent provinces of Brazil.

6. Population.—The population is 1,337,000. It consists chiefly of Indians, a few whites and the mixed breeds.

7. Chief towns.—Asuncion (ah-soon-se-own'), the capital on the left bank of the Paraguay, is a neat and cleanly city. It is situated nearly opposite the junction of the Paraguay and Pilcomayo Rivers, 1000 miles from the sea. Concepción (kon-sep-se-own'), in the north, Curuguaty (koo-roo-gwah'-te), near the centre, and Villa Rica (veel'-yah re'kah), south of the centre, are the other principal towns.

8. Government.—Paraguay formerly included all the territory between latitude 16° south and the Straits of Magellan, and between Brazil on the east and Chili and Peru on the west; but revolts and cessions reduced it to the small strip between the Paraná and Paraguay Rivers. It has lately extended its borders westward to the Vermejo.

9. This State declared its independence in 1810. In 1812, Dr. Francia, a native Creole, ursurped the government, made himself dictator, and ruled, from 1812 to 1840, with a vigorous hand. Some years after the death of Francia, Antonio Lopez became President. The government is a republic only in name. The people are better educated than those of the adjacent States. A good school system was organized by the Dictator Francia.

10. Religion.—The Roman Catholic religion is established. Since the edict of toleration issued by Lopez in 1846, other denominations have been tolerated, but they are not permitted to erect places of worship.

11. In the early part of the eighteenth century, the Jesuit missions of Paraguay included 100,000 Indian converts, who were taught reading, writing, a few of the simplest trades, and the use of arms. In 1759, the Spanish government, jealous of the intentions of the Jesuits, banished the teachers and broke up the missions.

4. A short section from the beginning of a text-book in English for beginners, presumably children in the second or third or fourth year of school life.

*The Mother Tongue,* pp. 4 (last paragraph) and 5

You have enjoyed reading "Hiawatha" and "The Village Blacksmith," which Mr. Longfellow wrote for you. When he was a little boy, living in Portland, Maine, his father went to Boston, many miles away. He wished to tell his father something; but of course he could not talk to him. So he wrote a letter to tell what he wanted. Here is the letter.

When you look at it, you will see that his father could understand the boy's thoughts and wishes by reading the written words quite as well as if they had been talking together.

PORTLAND, January, 1814.

DEAR PAPA, — Ann wants a Bible like little Betsy's. Will you please buy her one if you can find any in Boston?

I have been to school all the week, and got only seven marks. I shall have a billet on Monday.

I wish you to buy me a drum. H. W. L.

Could you have done so well?

When Mr. Longfellow was a boy, he knew how to express his thoughts in writing. His letter tells you just what he wanted. When he became a man, he expressed his thoughts so well that everybody was glad to read them. He used the same language which you use, but he used it better than you can. He knew far more about it than you do, just as travelers who have seen the rivers of ice in the north and the tangled forests of the south, know more of the earth than men who have always stayed at home.

There is a right way of doing everything, as well as several wrong ways. There is a right way to spin a top, to set a table, to harness a horse, to write a letter, to express a thought. This book will help you *to speak and write correctly*, and to choose words which will express just what you desire to say. That is, it will help you to make an intelligent use of your mother tongue.

5. Selections from the opening chapters on elocution of a reader for "children from seven to twelve years of age."

*The Independent Fourth Reader*, pp. 13-20 (page 13 is the beginning of the text).

Page 13.

Elocution is the mode of utterance or delivery of anything spoken. It may be *good* or *bad*.

*Good* elocution, in reading or speaking, is uttering ideas understandingly, correctly, and effectively. It embraces the two general divisions, ORTHOEPY and EXPRESSION.

Elocution { Orthoepy / Expression

ORTHOEPY

ORTHOEPY is the art of correct pronunciation.

It embraces ARTICULATION, SYLLABICATION, and ACCENT.

Page 17.

III

COGNATES

First require the student to pronounce distinctly the word containing the atonic element, then the subtonic cognate, uttering the element after each word — thus: li*p*, *p*; or*b*, *b*, etc. The attention of the pupil should be called to the fact that cognates are produced by the same organs, in a similar manner, and only differ in one being an undertone, and the other a whisper.

After more definitions and instructions like these and some exercises in pronouncing the vowels and consonants we find the following lesson:

Page 19.

V

ORAL ELEMENTS COMBINED

After the instructor has given a class thorough drill on the preceding tables as arranged, the following exercises will be found of great value, to improve the organs of speech and the voice, as well as to familiarize the student with different combinations of sounds.

As the *fifth* element represented by *a*, and the *third* element of *e*, are always immediately followed by the oral element of *r* in words, the *r* is introduced in like manner in these exercises. Since the *sixth* sound of *a*, when not a syllable by itself, is always immediately followed by the oral element of *f*, *n*, or *s*, in words, these letters are here employed in the same manner.

TONICS AND SUBTONICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| 1. | ba | ba | ba | ba | bar | baf | be | be | ber |
| | 1 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | |
| | ib | ib | ob | ob | ob | ub | ub | ub | oub |
| | 1 | 2 | 3 | 4 | 5 | 6 | 2 | 2 | 3 |
| | da | da | da | da | dar | das | de | de | der |
| | 1 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | |
| | id | id | od | od | od | ud | ud | ud | oud |
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 |
| | ga | ga | ga | ga | gar | gan | ge | ge | ger |
| | 1 | 2 | 1 | 2 | 3 | 1 | 2 | 3 | |
| | ig | ig | og | og | og | ug | ug | ug | oug |

(Seven similar tables follow.)

6. The first lessons in arithmetic from *Arithmetic on the Productive System*, by R. C. Smith.

## ARITHMETIC[1]

### Part First:

### Being a mental[2] course for every class of Learners

### NUMERATION[3]

Recite by the questions

1. Number, which shows how many are meant, is represented[4] by letters, by words, and by characters[5] called figures, as:—

| | | | | |
|---|---|---|---|---|
| One | I | 1 | One hundred | C | 100 |
| Two | II | 2 | Two hundred | CC | 200 |
| Three | III | 3 | Three hundred | CCC | 300 |
| Four | IV* | 4 | Four hundred | CCCC | 400 |
| Five | V | 5 | Five hundred | D or IↃ† | 500 |
| Six | VI | 6 | Six hundred | DC or IↃC | 600 |
| Seven | VII | 7 | Seven hundred | DCC or IↃCC | 700 |
| Eight | VIII | 8 | Eight hundred | DCCC or IↃCCC | 800 |
| Nine | IX* | 9 | Nine hundred | DCCCC or IↃCCCC | 900 |
| Ten | X | 10 | One thousand | M or CIↃ | 1000 |
| Eleven | XI | 11 | Two thousand | $\overline{\text{II}}$ or MM | 2000 |
| Twelve | XII | 12 | Three thousand | $\overline{\text{III}}$ or MMM | 3000 |
| Thirteen | XIII | 13 | Four thousand | $\overline{\text{IV}}$ or MMMM | 4000 |
| Fourteen | XIV | 14 | Five thousand | $\overline{\text{V}}$ or IↃↃ | 5000 |
| Fifteen | XV | 15 | Six thousand | $\overline{\text{VI}}$ or IↃↃM | 6000 |
| Sixteen | XVI | 16 | Seven thousand | $\overline{\text{VII}}$ or IↃↃMM | 7000 |
| Twenty | XX | 20 | Eight thousand | $\overline{\text{VIII}}$ or IↃↃMMM | 8000 |
| Thirty | XXX | 30 | Nine thousand | $\overline{\text{IX}}$ or IↃↃMMMM | 9000 |
| Forty | XL* | 40 | Ten thousand | $\overline{\text{X}}$ or CCIↃↃ | 10000 |

. . . . . .

* Or, IIII for 4; VIIII for 9; XXXX for 40: LXXXX for 90; and CM for 900.

† Every Ↄ annexed to IↃ increases its value 10 times; as IↃ, is 500, IↃↃ is 5000. In like manner the prefixing of C and annexing of Ↄ to CIↃ increases it 10 times, as CIↃ, 1000, CCIↃↃ, 10000; lastly a line over any number increases it 1000 times; as D, 500, $\overline{\text{D}}$, 500000.

. . . . . .

NOTE.—L. stands for the Latin language; G. for the Greek, and F. for the French.

[1] Arithmetic (G. *arithmetiké*), Computing, calculating or reckoning by numbers.

[2] Mental (L. *mentis*), Pertaining to the mind; intellectually.

[3] Numeration (L. *numeratio*), Numbering; the method or act of numbering.

[4] Represented, Exhibited; described; personated; to supply the place of.

[5] Character, A mark; a stamp; a letter; reputation; a personage.

| | | | |
|---|---|---|---|
| Fifty ..... L..... | 50 | Twenty thousand ..... $\overline{XX}$ or CCIↃↃCCIↃↃ | 20000 |
| Sixty ..... LX ..... | 60 | Fifty thousand..... $\overline{L}$ or IↃↃↃ ..... | 50000 |
| Seventy .. LXX ... | 70 | One hundred thousand.. $\overline{C}$ or CCCIↃↃↃ..... | 100000 |
| Eighty ... LXXX.. | 80 | Five hundred thousand. $\overline{D}$ or IↃↃↃↃ..... | 500000 |
| Ninety ... XC* ... | 90 | One million..... $\overline{M}$ or CCCCIↃↃↃↃ... | 1000000 |

*Questions on the Foregoing*

2. What does Number show? 1. How is it represented? 1. What letters and what figures stand for one, four, five and nine? What for ten? Ans. The figure 1 and 0 called naught or cipher.

3. What letters and what figures stand for eleven? For twelve? Fifteen? Twenty? Forty? Fifty? What different numbers may be represented by the figures 1 and 5 written together? Ans. Fifteen and fifty-one; as, 15, 51.

4. What different numbers may be expressed by the figures 1 and 9? 2 and 5? What number is expressed by C? by D? by M? What by C, D, M, with a dash over each?

5. What figures stand for one hundred? For two hundred? One thousand? Ten thousand? One hundred thousand? One million?

## 7. *Mental Arithmetic;* Thomson (designed for beginning students in primary departments).

*Lesson 1*

To Teachers. — The following Lessons assume that the class have an imperfect knowledge of *counting,* and of *elementary numbers.* The object is to show them practically *how many things* each number expresses, and impart to them a *distinct idea* of *more* and *less.*

1. How many of these little girls and boys can count? All who can, may hold up a hand.

2. The teacher puts down a counter,[1] as a book, and asks, "How many books are here?" The class answer "One book." Putting down another, "How many now?" "Two books." Putting down another, "How many now?" "Three books."

3. Hand me one book. Hand me two books. Hand me three books.

4. Each show me one finger. Show me two fingers. Three fingers. Four fingers. Five fingers.

[1] The teacher is supposed to be furnished with a Blackboard, a Numeral Frame, and a box of Counters; the pupils with small slates and pencils. For "counters," he may use any convenient portable objects; as, pebbles, bits of paper, pencils, cents, etc. Blocks of one, two or three cubes, and so on, up to a block of ten cubes, distinctly marked upon it, are also valuable aids.

5. When you say, one, two, three, four, five, etc., what is it called? Ans. Counting.

6. Again, putting down three books and then another, the teacher asks, "How many now?" "Four books." Putting down another, "How many?" "Five books."

7. The first child may hand me "one book." The next, "three books." The next, "two books." The next, "four books." The next, "five books."

8. Each hold up two fingers. Four fingers. Three fingers. Five fingers.

The thumbs are often regarded as fingers, and in counting may be so considered by the class.

9. Make two straight marks upon your slate; now make another beside these and count them.

10. Make one more beside these and count them.

11. Make one more and count them all.

12. What number comes after one? (The class answer in concert.) What comes after two? What after three? After four?

13. Two comes after what? Three after what? Four after what? Five after what?

14. What comes before five? What before four? Before three? Before two? Before one?

15. Count from one to five in concert.

16. Count from five to one backward in concert.

17. How many of the class can express the numbers, one, two, three, four, five, by figures?

18. Make the figure 1 (one) upon your slates (the teacher writing it upon the blackboard).

19. Make the figure 2 (two). The figure 3 (three). The figure 4 (four). The figure 5 (five). Make each of these figures twice more.

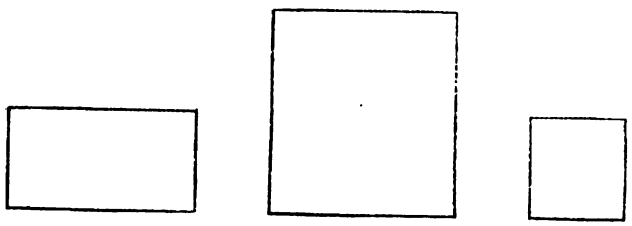
8. A selection from *Speer's Elementary Arithmetic.* The quotation from the introduction shows what may be expected of the pupils for whom the lesson is designed. The lesson is the first of their second year's work.

*Introduction*

Normal State of the Pupil. If the work of the first year has been rightly carried on there will be a tendency to look at things, to handle them, to compare them, and to express freely what is discovered. Continued growth requires continued fostering of this disposition. The mind that is not exercised in observing and comparing loses power to picture

conditions, to see things as they are. Growing power to judge involves continued sensing, imaging, and expressing.

PART I




*Ratios.* — 1. Tell what you can about *a*, *b* and *c*.

2. *b* equals how many times *a*? *c* equals how many times *b*? *c* equals how many times *a*?

3. *a* equals what part of *b*? What part of *c* equals *a*?

4. If *a* is 1, what is *b*? what is *c*?

5. If *c* is 1, *b* equals what part of 1?

6. If *c* is worth 40 cents, what part of 40 cents is each of the others worth? If *a* is worth 10 cents, how many 10 cents is each of the others worth?

7. If the length of *a* is 1, what is the length of *b*? of *c*? What is the width of *b*?

8. Show me the square whose length is 1; the square whose length is 2. The square of 1 equals what part of the square of 2?

9. Draw a line and call it 1; draw the line 2. Draw the square of the 1; of the 2. The square of the 1 equals what part of the square of 2?

10. Draw a line six inches long on the blackboard and call it 1; draw 2. Draw the square of the 1 and of the 2 Compare the squares.

11. Cut a square of 1 and a square of 2. Compare.

12. Draw the rectangles *a*, *b*, *c* on the blackboard, making *a* 6 in. long. Review.

13. Draw rectangles again, making *a* 1 ft. long and *b* and *c* 2 ft. long. Review.

9. A selection from Peabody's *Chronological History of the United States* for the use of schools. Four pages of narrative are given to be studied, and then the teacher is to put the following questions:

SPANISH ADVENTURERS

Who was Ponce de Leon? Where is to be found an account of his adventures? What was he doing when he discovered Florida? Why did he name it Florida? How did Charles the Fifth reward him for his discovery? What became of him?

What was Vasquez de Ayllon about, when he discovered Chicora? What do we call Chicora? How did he succeed in his undertaking? How was he rewarded for this cruel act? What was his success and fate?

Where had Stephen Gomez been in 1519? What did he undertake to do in 1525? What harbors did he explore? What cruel thing did he do, when he was disappointed of finding the northwest passage to India?

When did Narvaez attempt to conquer Florida? How many men had he? How did the Indians act? How many miles, and where did the Spaniards ramble? What became of them at last?

Who was Ferdinand de Soto? How came he to be appointed to conquer Florida? What were the preparations? What was his first act when he landed? How did the natives manage? Where did the party go? How did they act toward the natives? What discoveries did the Spaniards make? What became of de Soto? When did he die? Where was he buried?

What was the cause of Melendez being sent to conquer Florida? Who was Melendez? How was he induced to go and fitted out? Why did he so name St. Augustine? How did he announce himself to the French? What did he do first on landing? How did he find the French fort? How did he act? To what then does St. Augustine owe its origin? How much older is it than any other city in the United States? Was Melendez' cruelty punished? How long was it from Ponce de Leon's discovery to the founding of St. Augustine? What happened in 1512? 1520? 1525? 1526? 1537? 1542? 1565? Why is the red put in the eighth subdivision of the representation of these years? Why in the fifth subdivision of 1565? Why in the upper triangle of the second subdivision? What does the orange color mean?

Further practical work will consist of answering some fifty or more practical problems taken from actual school practice, such as the following:

What would you do for a class of students who had difficulty in distinguishing past from passive? Why?

How would you advise students to learn a vocabulary in French? Why?

Why is it so hard for children to answer in complete sentences to such questions as "When did Abraham Lincoln die?"

Supposing the custom of extorting complete sentences from children whenever they speak to be desirable, how could you make it less unnatural?

A girl constantly misspelled *to, too,* and *two.* How would you try to cure her?

A teacher gave children some flowers to classify with the expectation that they would put those together which had similar structures. Many of the children classified them by their color. To what was their mistake due? What do you think would have been the best way of avoiding it?

The next division of the work of the course comprises the study of two texts, Fitch's *Lectures on Teaching,* a general manual of wholesome advice, and McMurry's *Method of the Recitation,* a presentation of the so-called " formal steps." This work is accompanied by one to three hours a week of observation in the Horace Mann School. The aim of this division of the observation work is the intelligent study of the methods used by the teacher from the teacher's point of view. To secure this sympathetic study, the observation periods will be so arranged that a reasonably complete and continuous study of some feature of the teacher's work will result. As in the other observation work, the students will be divided into groups of six. The co-operation of the teachers of the School is relied on to make this observation work an intelligent study of the normal life of the school room under the direction and from the point of view of those who know it intimately, the teachers themselves.

Further practical work will consist of plans for class lessons, demonstrations, home-work, reviews, etc. The student will be required to plan each of these to fit some definite class in some definite school. It is expected that some if not all of these will receive criticism and correction from the officers of special departments and the critic teachers of the School, as well as from the instructor in charge. Finally each student is required as part of the work of the course to present a scrap-book of notes, references, quotations, diagrams, illustrations, etc., classified according to school subjects and maturity of scholars, collections of use in teaching science, history, etc., etc. The aim of this work is to form in students the habit of thinking of schoolroom needs, of making their general reading and experience contribute to the enrichment of the courses of study they administer and of choosing material relevant to actual school work and suited to children of different ages.

The last division of the course will be occupied with lectures and discussions concerning the elements of personality which are characteristic of good teachers, and the possibility and methods of cultivating them. The aim will be to direct students to profitable ways of increasing their professional efficiency by the criticism of personal traits. The topics will be the following:

> Personality not an utter mystery — changes in personal make-up occur — to some extent are within our power. — The desirable elements in personality in the case of the teacher. Orderly, ready, related knowledge — value of the study of composition and of masterpieces of exposition — of practice in quick use of the knowledge at one's command — of the study of the relationships of any body of knowledge taught to the rest of knowledge. Clearness and vigor in extemporaneous speech — value of all rhetorical practice. Posture, voice, dress, freedom from eccentricities. Ready and accurate observation of children's acts, moods, desires, feelings, etc. — of the idea behind the words — value of living with children, of trying to make such observations and testing one's guesses. Liking for children — value of treating them as if one did like them — doing things for them, etc. Common sense — equivalent to the absence of bizarre notions, sentimentality, a doctrinaire temper, and the presence of some power of humor and self-criticism and of appreciation for the golden mean in things — partially acquirable — value of much intercourse with all classes of people, abandonment of hobbies, systematic practice in doing as others do, making fun of one's self, seeking and destroying one's extravagances and petty peculiarities. Personal magnetism — equivalent in part to self-confidence, enthusiasm, erect posture, looking people in the eye, mastery of a multitude of devices for suggestion. Value of saving time by not worrying, doubting or wondering about success or failure — of accepting every activity proposed, of doing new things whenever the chance arises.

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## THE ECONOMICS OF MANUAL TRAINING


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## ANNOUNCEMENT OF VOLUME III — 1902

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| **No. 1 January** | Papers by Dr. D. C. GILMAN, Ex-President of Johns Hopkins University, Professor S. T. DUTTON and others on *Present Day Problems in Education.* |
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TEACHERS COLLEGE RECORD

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# THE ECONOMICS OF HAND WORK IN ELEMENTARY AND SECONDARY SCHOOLS

BY LOUIS ROUILLION

Instructor in Mechanical Drawing in Teachers College, Columbia University

The purpose of this paper is to put in brief and concise form such information regarding the cost of installing and maintaining manual training as part of a school curriculum as may be of interest and help to a superintendent or other school official in facing this problem.

The theory and practice of hand work in the school has already been discussed in a special issue of the TEACHERS COLLEGE RECORD, Vol. 1, No. 5. The factor of cost is the only element that falls within the province of this paper. This factor is one of primary importance and is frequently the rock upon which the intention to introduce Manual Training into a school system is wrecked.

It is proposed herein to give definite data as far as is practicable as to the cost of Manual Training in each of the grades and the four years of the high school. An endeavor will be made to make this information of a kind applicable to varying conditions of school work. It will be appreciated, however, that Manual Training in the grades is not a clearly defined quantity.

It may almost be said to vary directly with the number of cities and towns wherein Manual Training is a part of the curric-

ulum. At present the practice of Manual Training is happily progressing from the state of fixed self-contained courses in different media, aiming purely at proficiency in certain processes to the freer use of hand work as an expression of the various school interests and needs.

For such work it is evidently far more difficult to render an estimate of expense than for the older conditions, and the best that can be done is to analyze as far as possible the data of costs upon the basis of various materials and processes and leave to the reader the task of making the necessary deductions.

The lack of uniformity in Manual Training practice, at the present time, is especially true in the lowest grades. In the later stages of the elementary school, and particularly in the high school, the character of the work becomes more and more uniform, both as to processes and actual undertakings.

This is in part due to the historic development of the subject in our country. Logical development and growth would seem to demand the primary introduction of such work in the kindergarten and its gradual incorporation in successively higher grades until the high school is reached. This, however, is almost the reverse of the actual fact. Hand work did indeed make an early appearance in the kindergarten, but its arrival in the public schools was in the high school field, and from this point it has worked gradually downwards in the grades bearing generally strong evidences of the original influences.

The character of the early work done in the high schools, which has persisted to the present time in only a slightly modified form, was very greatly influenced by the recently organized shop work courses of certain engineering schools. In these courses a quite uniform school of instruction had been developed, involving joinery, turning and pattern-making in wood, followed by forging and foundry work and finally by machine work. When the first Manual Training High schools were organized their manual training work was patterned in general character and even in detail upon these courses, and in the rapid spread of such schools this general scheme has remained substantially unchanged.

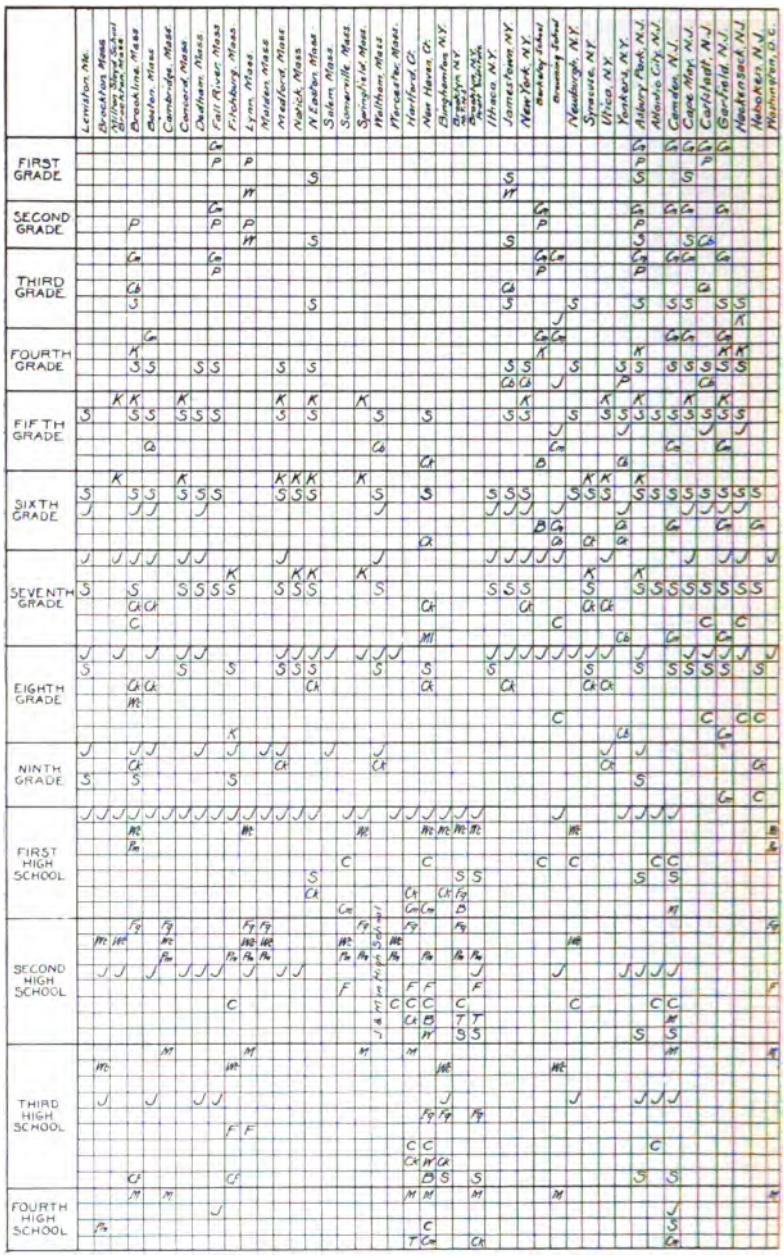
The more recent introduction of Manual Training into the regular high school has, however, resulted in modifications in the general plan. This is partly traceable to the lesser propor-

tion of the school time allotted to shop work, partly to the attitude maintained towards the subject, and sometimes to the lack of sufficient funds to completely equip a full set of shops. The plan in such schools is naturally to expand simpler elements over more time and to omit the later and more expensive branches. In the elementary school the practice of bench work in wood quite generally prevails in the eighth and seventh grades. This work is also of a quite definite character, and its acceptance as the best adapted branch of hand work for the boys of the two upper grades of the grammar school seems assured. Below the seventh grade the variations in practice begin to be marked. In some schools the inclination is to begin bench work in the sixth and even in the fifth grade. The trend of the larger number of cases appears, however, to be to introduce into the sixth and fifth grades wood work not requiring benches and a separate laboratory equipment. This kind of work is very commonly known as knife work or whittling. Work in cardboard is often found in the next lower grades; say, the fourth and third. This work is actually carried on, in some schools, in any or all of the grades from the second to the seventh. Work in bent iron (often called Venetian iron work) is frequently used in the fifth and fourth grades. In the first three grades are found clay modeling, paper folding, weaving and sewing, more or less correlated with the other studies of these grades.

The accompanying Table A was compiled chiefly from data furnished by the various schools in answer to requests made to them by letter. The table shows the manual training subjects given in each of the grades and in each of the high school years, in the schools enumerated.

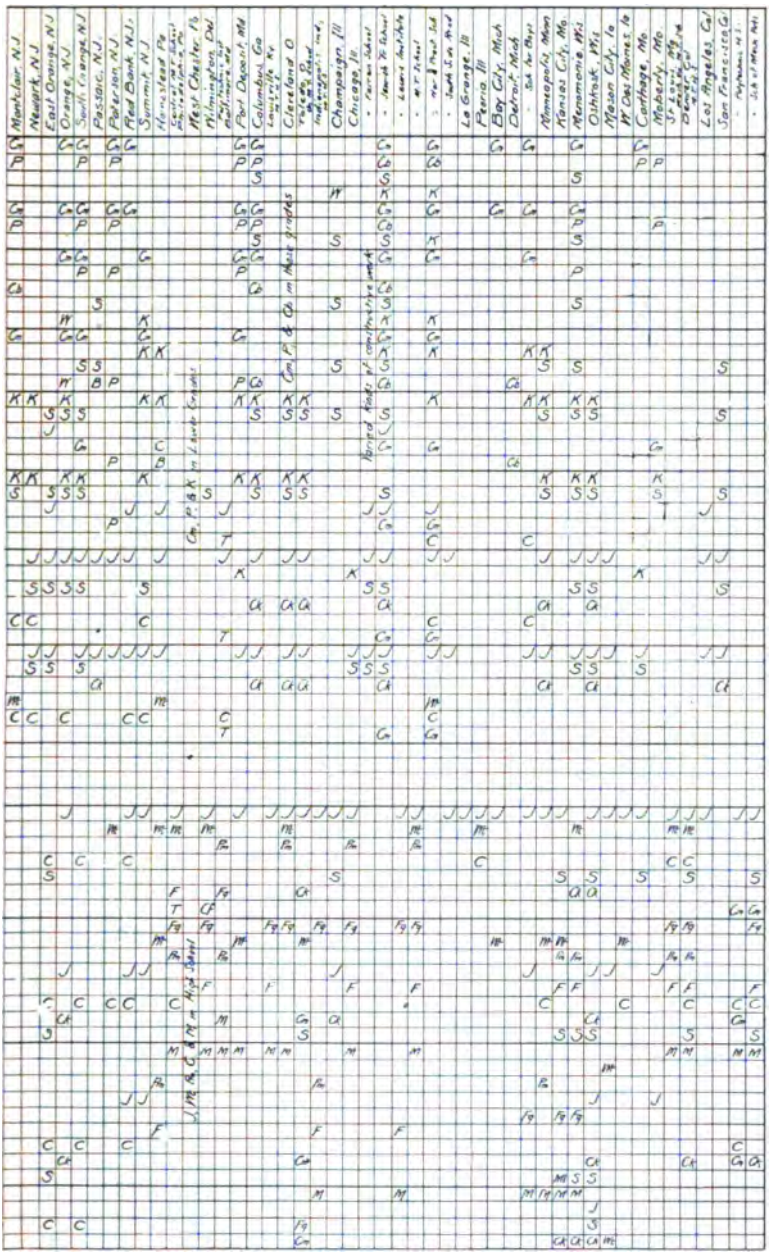
The division of the elementary school course differs in different parts of the country. Schools with seven, eight, and nine-year courses are represented in the table. In the high schools both three and four-year courses are represented. The table is arranged so as to show at a glance the prevailing subject taught in any one year and to afford an opportunity of comparison. In the subsequent consideration of subjects taught in the various grades the basis assumed is that of eight-year elementary course and a four-year high school course.

A somewhat complete bibliography of books on the methods and practice of Manual Training will be found below.




*Cm* Clay Modeling.— *P* Paper Work.— *Ch* Cardboard Work.— *W* Weaving.— *K* *Wt* Wood Turning.— *Pm* Pattern Making.— *M* Machine Shop Work. — *Ml* Millinery.

TABLE *A*.— MANUAL TRAINING SUBJECTS GIVEN IN THE



**Knife Work. — *S* Sewing. — *B* Bent Iron Work. — *Ck* Cooking. — *J* Joinery. — *Fg* Forging. — *F* Foundry. — *C* Carving. — *Cf* Chipping and Filing. — *T* Tinsmithing.**

VARIOUS SCHOOL YEARS IN THE SCHOOLS ENUMERATED.

All such general items as teachers' desks, chairs, and blackboards have for convenience been omitted from the following schedules.

## ELEMENTARY SCHOOL

Manual training in the first three grades is generally carried on in the regular class room, under the instruction of the regular teacher, and at a nominal cost. The work customarily assumes some phase of modeling in clay, construction in paper, sewing, and weaving with various materials. This work is accomplished in many instances at an expenditure of but two cents per pupil. Some schools expend five times that amount and even more. Under competent and economical management the cost in these grades need be but slight. This work at the present time is greatly diversified in character and depends largely upon the ability, sympathy, and inventiveness of the teacher.

CLAY MODELING. — By reference to Table A it will be noted that clay modeling is generally taught in the lower grades. Supt. Carrol contends that clay modeling may profitably be carried on from the kindergarten through the high school.

Clay costs, in most large cities, from one and one-half to three cents per pound. By washing and re-using the clay the total amount needed per pupil may not exceed two pounds. Hygienic objections have been raised to such re-use of the clay, but do not seem to be sustained by any evidence. The principal item of expense in the use of clay in the schools is the labor involved in either reworking the old or preparing new clay for use. This labor is generally too severe to be borne by the regular teacher and must be provided by the janitor or some other assistant. If the children are permitted to retain their work the cost of material may increase to perhaps fifteen cents per pupil and upwards.

The clay may be handled on a small board, a slate, a piece of enamelled cloth, or on a piece of common Manilla paper that is thrown away after use. During the first two years the clay is generally worked by the hands alone. For the third year a simple modeling tool, costing about six cents, is commonly introduced. There are various substitutes for clay upon the

market, but their common objection is their cost. Composite clay costs twenty cents per pound; Plastilina thirty cents per pound. Paper pulp has been used as a substitute. The following quotation, from the instructions issued by the Manual Training Department of the Elementary Public Schools of Chicago, may be of interest here: "Paper pulp is a substance which any one can easily make and use in place of clay...for modeling. The material costs nothing and is so clean and pleasant to work, it is surprising paper pulp has not been more generally applied in constructive work. To make pulp of papier mâché, tear any waste paper (newspaper or writing paper will do) into pieces not more than one inch square. Fill a bucket with these bits of paper and pour over it about a gallon of hot water (boiling). Let the paper soak for five or six hours and then drain off the excess water. If now the mass of wet paper is worked vigorously with a stick, churning it and thus tearing the bits of paper very fine, you will have, at the end of a few minutes, an excellent quality of paper pulp. The pupils will enjoy the making as well as the using of this material."

CONSTRUCTION IN PAPER is one of the most common forms of hand work in the first two grades. Its use in the third grade is also quite general. (See Table A.)

For this work each pupil requires a pair of scissors. Suitable scissors may be had at $3.00 per dozen, making the cost of equipment for a class of thirty $7.50. In third-grade work each child is generally also supplied with a pencil and foot rule, involving a further outlay of $1.20, making a total cost of equipment for a class of thirty in paper work at this stage, $8.70.

If the above equipment is used by but a single class of thirty, as in a private school, the cost per pupil is 29 cents. If, however, this same equipment is used by two or more classes, as in public school work, the cost per pupil for equipment is reduced to a much smaller figure. This method of duplicating the use of a single equipment may be practiced with advantage on the score of economy even to the extent of having an entire manual training outfit carried from grade room to grade room.

Varying practice in just such points as the above undoubtedly accounts to a degree for the discrepancy in the cost of equipment and maintenance as furnished by different schools.

The cost of supplies for paper construction is small. Thin paper, plain or colored, cut to the required size, is generally used at first. Later heavier paper, such as Manilla and cover paper, is introduced. These papers may be purchased at the following prices:

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manilla paper, | 80 | pounds, | 22″ | x | 28″ | . | . | $1.25 | per | 100 | sheets | | |
| " | " | 35 | " | 24″ | x | 38″ | . | . | .50 | " | " | " | |
| Cover | " | 50 | " | 22″ | x | 28″ | . | . | 1.10 | " | " | " | |
| Colored coated paper, thin, | | | | 6″ | x | 9″ | . | . | .60 | " | " | " | |

White paste, obtainable in tubes, or, more cheaply, in glass jars, is used in joining thin paper, and liquid glue for thicker papers and cardboard.

WEAVING, in various forms typical of primitive textile and basketry processes, is beginning to appear in many schools. The materials most used are, strips of colored paper, yarn, rags, raffia, grass and reeds.

*Prices*

| | |
|---|---|
| Colored paper | see above |
| Yarn — Cotton | 17 cents per pound upwards |
| Wool | 40 " " " " |
| Raffia | from 15 cents to 20 cents per pound |
| Reeds | from 40 cents per pound for No. 6 (⅛ inch in diameter), to 60 cents per pound for No. 2 ($^1/_{16}$ inch in diameter) |

CORD WORK. — Macrame cord costs from 25 cents per pound upwards, or 30 cents per skein.

SEWING is often represented in a number of the grade classes and also in the high school. In the earlier grades it is generally given to both girls and boys, and later to girls alone.

*Equipment for each class of thirty in the first, second and third grades*

| | |
|---|---|
| 30 scissors, @ $1.10, per dozen | $2.75 |
| 30 thimbles, Nos. 5, 6, 7, and 8, @ 30 cents, per dozen | .75 |
| 3 emery cushions | .15 |
| Total cost of equipment | $3.65 |

*Maintenance.* — Miss Jessie Patterson, in an article in the *Outlook,* after describing a course in sewing, writes as follows regarding the cost of maintenance:

"It is very difficult to give an estimate of the cost per child for a course in sewing. The actual cost for materials required for the course in plain sewing, which is given above, is thirty cents, allowing nothing for waste. Pratt Institute allows about twenty cents for each pupil. This covers the course in hand sewing for six grades, twelve lessons in each grade of two hours in length, and includes all the materials used for the various exercises. Teachers College, five grades, ten cents a year, one lesson a week of one hour and twenty minutes. The allowance in the public schools of Brooklyn for ten months, one lesson of one hour each week (in addition to the plant of scissors, emeries, etc.), is twelve to fifteen cents per child. New York, six cents a year, in four grades, one hour each week. Philadelphia, six cents, where two lessons each week, of forty-five minutes each, are given in primary schools, and one each week of one hour in grammar schools. Washington, fourteen and a half cents (including implements, etc., as well as materials), one lesson a week of one hour and a half is given. Boston, two and a half cents are allowed, and the course of study requires that in three classes of the grammar grades instruction shall be given for two hours each week. Minneapolis, eleven and a half cents. Cleveland, five and a half cents. In Boston and Philadelphia, children bring material from home."

The concluding line in the above paragraph suggests an important factor in the consideration of the cost per pupil for sewing.

A very important question here as in all other work is whether the work consists in copying a set of models or in the use of sewing in natural relations to the school interests.

A detailed statement of the kind, amount, and cost of the materials actually used in the work in sewing, cord work, and basketry by the pupils of the Horace Mann School in the first, second, third, sixth, and seventh grades during the school year of 1900-01 is here given. This work was closely correlated with other studies, especially with nature study, reading and history.

*Materials used in Sewing, Cord Work and Basketry*

| | | | | |
|---|---|---|---|---|
| Burlap | 2¾ yards | @ | $ .75 | $ 2.07 |
| Java canvas, white | 3 " | " | .38 | 1.14 |
| " " colored | 3¼ " | " | .45 | 1.46 |
| Unbleached muslin | 10 " | " | .08 | .80 |
| White " | 4 " | " | .09½ | .41 |
| Victoria lawn | 4 " | " | .20 | .80 |
| Linen " | 1 yard | | | .90 |
| Heavy linen | ⅛ " | " | .75 | .10 |
| Long cloth | 12 yards | " | .12 | 1.44 |
| Gingham | ½ yard | " | .12 | .06 |
| Flannel | ½ " | " | .60 | .30 |
| Eider flannel | ½ " | " | .55 | .28 |
| Ribbon (different widths and different colors | 1 piece | " | .45 | .45 |
| Worsted (different colors) | 1¼ pounds | " | 1.45 | 1.82 |
| Cord | 10 " | " | .16 | 1.60 |
| Iron rings | ½ gross | " | .60 | .30 |
| Brass " | ½ " | " | .15 | .08 |
| Raffia | 18 pounds | " | .15 | 2.70 |
| Birch bark (Christmas) | 20 square feet | " | .12 | 2.40 |
| Chamois skins pen-wipers and mocasins | 4 | " | .25 | 1.00 |
| Rattan | 15 pounds | " | .35 | 5.25 |
| " | 10 " | " | .60 | 6.00 |
| Bobbin | 1½ dozen | " | .10 | .15 |
| Pearl buttons | 3½ " | " | .12 | .42 |
| Lace torchon | 3 yards | " | .10 | .30 |
| " val. | ½ piece | " | .25 | .13 |
| Stockinet | 1 yard | " | .08 | .08 |
| Darning cotton | ⅔ ball | " | .03 | .02 |
| Diamond dye | 6 packages | " | .10 | .60 |
| Braid (dolls) (different colors) | 1 piece | " | .05 | .05 |
| Braid (gold) | 7 yards | " | .05 | .35 |
| Buttons (gold) | 1 dozen | " | .15 | .15 |
| Cotton thread (approximate amount) | 1 " spools | " | .41 | .41 |
| Silk thread (approximate amount) | ½ " " | " | | .54 |
| Needles sharps | 1 " prs. | " | .48 | .48 |
| " tap | ½ " " | " | .48 | .24 |
| | | | | $35.28 |

The above materials were used by 165 pupils, making the cost per pupil about twenty-one cents.

*Bibliography.*—The numbers, in heavy-faced type, refer to the corresponding numbers in the bibliography below. The light-faced type refer to pages.

Clay modeling: **13**: 173–195 and sub. parts, **17**: 58–65, **22**: parts, **29**: 53–69, **32**: 98–107, 145–158, **53, 56**, parts, **57, 60, 76**: 180–198, 222–235, **77**: parts, **78**: **88**: 89–98, **96**: 146–156, **103, 105, 112**: 61–67, **126, 127, 132, 134**: 185–261, **137**.

Paper Work: **9, 13**: 1–19, **14**: Part II, 86 pp., **22**: parts, **27**: parts, **28**, 22–122, **29**: 12–19, **32**: 25–55, **54, 56**: parts, **76**: 1–83, **77**: 22–30, 44–47, 68–81, **88**: 65–84, **93**: parts, **112**: 24–54, **122**: 7–27, **129, 145**.

Cord Work: **13**, 79–80, **14**, Part II; 45–72, **28**: 124–128, **29**: 23–29, **32**: 69–80, **109**: 282–284, **143**.

Weaving and Plaiting; with Paper: **13**: 20–47, **29**: 19–23, **32**: 65–69, **77**: 25–27, 41–44, 60–74, **144**. With Cane, Rushes, etc.: **13**: 129–149, **29**: 29–32, **32**: 80–98, **37, 67, 82, 91, 144, 148**.

Sewing—see page 00.

**Fig. 1.** Cardboard Construction in Regular Grade Room, Buffalo, N. Y.

CONSTRUCTION IN CARDBOARD is a common type of work in the third, fourth and fifth grades. The work is generally done in the regular class room under the direction of the regular teacher.

*Equipment for class of thirty pupils*

| | |
|---|---|
| 30 pairs scissors @ $3.00 | $7.50 |
| 30 compasses | 3.17 |
| 30 rulers | .43 |
| 30 triangles | 1.75 |
| 2 punches | .80 |
| Total cost of equipment | $13.65 |

Fig. 2. Bent Iron Work in Special Room with Simple Equipment, Buffalo, N. Y.

## *Maintenance*

Cardboard: 120 pounds to 500 sheets, 22 x 28, 90 cents per 100 sheets.
" 140 pounds to 500 sheets, 22 x 28, $1.00 per 100 sheets.
Cover-paper: 120 pounds 22 x 28, $2.64 per 100 sheets.
Straw-board: 26 x 38, $1.10 per bundle.
Press-board (red): 80 pounds to 144 sheets, 24 x 32, 65 cts. per doz. sheets.
Cost per pupil for cardboard work in the schools of Detroit is about 6½ cents.

*Bibliography.*—**9**, **13**: 48–78, **17**: 24–34, **22**: 55–67, **27**: parts, **29**: 32–53, **32**: 55–65, 107–145, **36**: 23–31, **45**: 38–76, **55**, **56**: 205–229, **65**, **76**: 138–178, 199–222, **77**: 81–94, **88**: 84–88, **96**: 34–47, **102**, **112**: 54–60, **118**: 33–41, **122**: 27–117, **136**.

BENT IRON WORK is also carried on in the fourth and fifth grades. As in all the earlier grade work, it is usually operated in the school room by the class teacher.

*Equipment for class of thirty pupils*

| | |
|---|---|
| 30 flat-nose pliers @ $2.30 | $5.75 |
| 30 round-nose pliers @ $2.30 | 5.75 |
| 15 pairs snips @ 90 cents | 13.50 |
| 30 rulers | .43 |
| 1 cutting machine | 3.25 |
| Total cost of equipment | $28.68 |

Fig. 3. Simple Wood Work with Knife in Regular Class Room, Buffalo, N. Y.

*Cost of maintenance for class of thirty in Horace Mann School*

| | |
|---|---|
| Binders @ .09 per 100 | $2.70 |
| ¼-inch iron @ .21 per coil of 50 feet | 2.10 |
| Black paint @ .25 per tube | .50 |
| 30 pencils | .60 |
| Total cost of maintenance | $5.90 |
| Cost per pupil, about | .20 |

*Bibliography.*— 13: 166–175, 33, 74: 173–201, 89: 1–34, 97, 108. Wire work: 13: 149–162, 14, Part III, 29: 85–96, 32: 183–209, 36: 31–39, 45: 108–116, 56, parts, 88: 100–103.

WHITTLING, OR THIN WOOD WORK, is frequently carried on in the fourth and fifth grades. Both thin and thick woods are used with the knife as the sole cutting tool. The work is often conducted by the regular teacher in the regular class room. The desk tops may be protected by especially designed desk covers. A cabinet for the storage of these trays must be provided. It may be mounted on castors to permit of its being moved from room to room. The desk cover, however, and consequently the cabinet, may be dispensed with, thus reducing considerably the cost of equipment.

*Equipment — Individual for class for thirty pupils*

| | |
|---|---|
| 30 Sloyd knives @ $4.05 per dozen | $10.13 |
| 30 tri-squares @ $1.58 per dozen | 3.95 |
| 30 compasses @ $1.00 per dozen | 2.50 |
| 30 pencils @ .24 per dozen | .60 |
| 30 rulers @ .12 per dozen | .30 |
| 30 45°-triangles @ .50 per dozen | 1.25 |
| 30 30°-60°-triangles @ .50 per dozen | 1.25 |
| 30 T-squares @ .63 per dozen | 1.58 |
| 30 trays @ $8.10 per dozen | 20.30 |
| Total cost of individual equipment | $41.86 |
| Total cost of individual equipment, without trays, triangles, and T-squares | $18.98 |
| General equipment: | |
| 6 brad awls | $ .19 |
| 1 1¼-inch auger and bit | 1.25 |
| 6 hammers | 1.80 |
| 6 grooving tools | 1.50 |
| 1 small back-saw | .82 |
| 4 fret-saw frames | 2.60 |
| 4 dozen fret-saw blades | .32 |
| 1 oil-stone and can | .90 |
| 1 honing strop | .25 |
| 3 quires of sandpaper | .48 |
| 1 cabinet | 20.00 |
| Total cost of general equipment | $30.11 |
| " " " complete " | 71.97 |
| " " " " " without tray outfit, | 47.59 |

A neat box, containing an outfit for a class of twenty in whittling, can be purchased from dealers in manual training supplies. The outfit contains twenty each of the following: rule, pencil, compass, sand-paper block, try-square, and knife, and also a chart of models. The retail price is $15.00.

A chest containing the following general tools and supplies retails at $750: saw, oil-stone, 2 honing strops, 6 auger bit gimlets, hatchet, oil can, and 2 quires of sandpaper. The above prices are subject to discount.

Fig. 4. Wood Working Equipment for the Elementary School, Westbrook, Me.

## *Maintenance*

Stock — Basswood, 1/8", 3/16", or 1/4" thick, can be obtained in pieces, 4" x 9". @ $1.00 per hundred. If a considerable quantity is needed, a slight saving can be made by having the lumber cut to required sizes at a mill.

Cost per pupil, usually about 10 cents.

*Bibliography.*—**22**: 68–74, **29**: 101–105, **36**: 14–26, **58, 77, 79, 114.**

BENCH WORK IN WOOD.—Seventh and eighth grades. Up to this point the question of the cost of equipment has not been a serious one, nor one acting as a factor to give pause to the introduction of manual training. Beginning with the bench work in wood and continuing through the high school work, the cost of the initial equipment becomes a matter of much moment and deserving of considerable thought and study. Specially fitted-up rooms have now become a necessity, as have also special teachers. The following estimate on equipment is based on the assumed possession of an empty room, or rooms, to be completely equipped for the intended purpose.

For working in wood provision must be made for the storage of lumber either in the form of boards, or cut to sizes for class use, or both. If the lumber is purchased in the rough and a considerable amount is required it is desirable that a circular saw be provided for cutting the lumber into sizes suitable for class use. Power in this case will be required to run the saw. If the bench work is done upon a limited scale the lumber may be purchased cut in suitable sizes and then stored on shelves or pigeon holes. Storage facilities for unfinished work of pupils must be provided either in the form of a group of pigeonholes or a compartment in the bench. A panel or cupboard to hold the general tools arranged at some convenient point should be provided. It is desirable that there should also be some arrangement for disposing of shop clothes of the pupils, and facilities for washing up.

There is a variety of work benches on the market specially designed for manual training schools and ranging in price from $5.50 to $12.00. Types of these benches are shown in the illustrations on the opposite page.

Simple benches to accommodate four or more boys at each bench can be made by a carpenter at a considerable reduction from the above figures. Such benches, although entirely practicable, are open to the objections that they are not as strongly constructed as the single framed benches and do not last as long, that the workers are liable to interefere with each other, and that adequate passage ways for the movements of the class and teacher are less easily secured.

Fig. 5. Wood Working Bench—Draw Bolt Construction.

Fig. 6. Wood Working Bench—Keyed, Mortise and Tenon Construction.

*Equipment for a class of twenty-four pupils*

| | | |
|---|---|---|
| 24 benches @ $5.50 to $12.00 each | $132.00 to $288.00 | |
| Tools for each bench: | | |
| (Prices quoted are net cost per two dozen.) | | |
| Rule, 2-foot, 2-fold, Stephens' No. 2 | | $1.98 |
| Sloyd knife, blade 2½ inches | | 8.10 |
| Marking gauge, Stanley's No. 65 | | 4.64 |
| Try-square, 6 inch | | 4.24 |
| Firmer chisel, ¼ inch | | 3.98 |
| " " ⅞ " | | 6.30 |
| Rip saw, 8 points, Disston's | | 23.76 |
| Back saw, 10 inches, Disston's | | 19.88 |
| Jack plane, Bailey's No. 5 | | 36.72 |
| Block plane, Stanley's No. 16 | | 16.20 |
| Spoke-shave, Stanley's No. 64 | | 1.72 |
| Bench-hook, wood | | 3.60 |
| " -brush | | 4.24 |
| Drawing kit, Bradley's No. 102 | | 9.60 |
| Total cost for bench tools | | $144.96 |
| Total cost for a single bench equipment: | | |
| Bench | $5.50 to $12.00 | |
| Tools | 6.04 | 6.04 |
| | $11.54 | $18.04 |

*General Tools*

The attempt has been made to arrange the following list of general tools in the order of their importance and desirability, so that, when necessary, curtailment may be made with least danger of impairing the efficiency of the equipment.

| | |
|---|---|
| 12 cross-cut saws, 10 points, Disston's | $10.59 |
| 12 hammers, Maydole No. 13 or Hammond's | 4.46 |
| 12 bit braces, 6" or 7" sweep, Barber's | 9.51 |
| 12 auger bits, ¼", Russell Jennings | 1.98 |
| 12 " " ½", " " | 3.16 |
| 6 " " ⅝", " " | 1.85 |
| 6 " " ¾", " " | 2.16 |
| 6 " " 1", " " | 2.82 |
| 3 centre " 1¼" | .52 |
| 6 drill " $^{3}/_{16}$" | .52 |
| 3 " " $^{7}/_{32}$" | .65 |
| 6 countersinks, ½", Rose's | .57 |
| 12 screwdrivers | 2.43 |

| | | |
|---|---|---|
| 4 | brad awls, 1″ | .13 |
| 8 | " " 1¼″ | .25 |
| 12 | carver's skew chisels, ½″ | 3.15 |
| 12 | " veining tools, 1/32″ | 3.87 |
| 8 | turning saws, 14″ x ⅛″ | 6.88 |
| 24 | compasses (with pencil attached) | 2.98 |
| 12 | hand screws, or iron clamps | 3.60 |
| 12 | Firmer chisels, ½″ | 2.42 |
| 6 | " gouges, ⅞″ | 1.66 |
| 6 | " " 1″ | 1.96 |
| 4 | " " ¾″ (inside bevel) | 1.27 |
| 4 | 10″ iron bevels, Eureka | 1.91 |
| 4 | oil-stones, 2″ x 8″, mounted | 2.85 |
| 4 | brass oil-cans, No. 1 | .65 |
| 2 | Washita oil-stone slips | .28 |
| 1 | set of carving tool slips | .61 |
| 6 | smooth planes, Bailey's No. 4 | 15.88 |
| 6 | cabinet scrapers (one end round) | .25 |
| 2 | mortise gauges, rosewood, Stanley's No. 77 | .78 |
| 8 | sets of winding sticks | |
| 1 | rabbet plane, Stanley's | .79 |
| 1 | 10″ try-square | .34 |
| 2 | burnishers | .61 |
| 2 | key-hole saws, iron handle | .21 |
| 6 | wing dividers, Peck, Stow & Wilcox's No. 5 | .75 |
| 12 | nail-sets (hollow points), knurled | .90 |
| 12 | hand bastard files, octagon handles | 2.08 |
| 6 | " " " half-round | 1.30 |
| 3 | file cards, Nicholson's | .46 |
| 8 | mallets | .56 |
| 1 | pair of cutting pliers | .61 |
| 2 | cabinet clamps, Bliss' No. 73 | 1.23 |
| 8 | Firmer chisels, 3/16 inch | 1.22 |
| 2 | joiner planes, Bailey's No. 7 | 4.47 |
| 1 | expansion bit | .72 |
| 1 | mitre-box, Langdon's No. 18 | 6.30 |
| 1 | hatchet | .58 |
| 1 | 7-inch drawshave, Witherby's | .47 |
| 1 | pair calipers, 6-inch wing | .26 |
| 1 | matching-plane, Stanley's | 1.53 |
| 1 | plow, Stanley's No. 45 | 4.86 |
| | In addition: | |
| 1 | grindstone, complete | 12.65 |
| 1 | glue-pot outfit | 4.00 |
| | Total cost of full general tool outfit | $129.50 |

Demonstration outfit, consisting of teacher's work bench and tools, blackboard, raised platform and benches for seats . $50 to $125.00

| | |
|---|---|
| Pigeon-holes and shelving for storage of stock, and pigeon-holes or lockers for storage of work | $40 to 100.00 |
| Benches, as above | $132 to 288.00 |
| Bench tools, as above | 144.96 |
| General tools, as above | $90 to 129.50 |
| Total cost of equipment | from $457 to $787.46 |

The above figures represent comprehensive and thoroughly efficient equipments. As an illustration of what may be done towards introducing woodworking upon a thoroughly healthy basis with very little expenditure, the following quotations are made from the 21st Annual Report of the School District No. 3, Sterling, Illinois:

"The tables which had done duty in the science room of the old Sterling High School made excellent work benches, and as soon as the fire-escape was completed sufficiently to allow us to use the third floor for school purposes without violating the State law, instruction in the new department was begun.

"Throughout the year the seventh and eighth grades of both schools have had regular instruction, one hour per week. Forty boys and thirty-four girls have taken the course. The initial expense in setting these pupils to work, including eight dozen sloyd knives, four dozen try-squares, four dozen coping saws, one rip-saw, two mitre-boxes and whitewood lumber was $46.78. The additional expense to carry the work through the year was about $38.00, making the total expense about $84.78.

"In May of this year, the girls of the two schools gave a 'Girls' Program' as a sequel to the 'Boys' Program,' which netted $28.45, and this was followed by a 'Primary Program' which netted $26.50, both of which amounts were turned over to the treasurer of the fund. We have thus raised for manual training purposes by public exercises $103.14, of which $84.78 has been expended. This expenses does not include $15.00 which the Board has paid for one dozen vises, nor the lumber for a dozen work benches.

"Of this material which the Board purchased for work benches, the boys of Lincoln school have made, out of school hours five benches, and enough material is on hand for seven more benches. The boys made these benches entirely themselves and they would be pleased to have the Board test the 'plumbness'

and 'squareness' with which they stand in the world and their fitness to meet a young workman's needs.

"I very much regret that at the present writing I have not access to all the bills above mentioned; but I am safe in saying that the total expense of conducting our first year's work in manual training was less than $110.00, and the greater portion of this amount is in tools and benches, and thus available for future work."

*Maintenance.*—The cost of maintenance is largely dependent upon the cost of lumber. There are other items as hardware and the wear on tools, and depreciation, but the chief item is that of stock. The kind of stock used as well as its cost varies greatly in different sections of the country. It is desirable that all lumber used should be of good quality and free from knots. The prices per 1,000 feet for such lumber used at the Horace Mann School are as follows:

| | |
|---|---|
| Clear pine | $75.00 |
| White wood | 47.50 |
| Gum " | 47.50 |
| White bass wood | 45.00 |
| Cypress | 42.50 |
| Ash | 60.00 |

If the material is to be planed and sawed to sizes for the class work an addition should be made to the above figures of about one cent per board foot.

A considerable item in the cost of maintenance of all shop work is the depreciation of tools, benches, and other fixtures through loss and wear.

A study of one equipment over a period of ten years and another over six years would seem to indicate that 10 per cent. is a conservative estimate of this factor. In many cases the loss would undoubtedly fall below this proportion.

In an endeavor to ascertain the cost per pupil for materials used in the bench work, the following table has been compiled. It will be noticed that there exists a very wide range in the costs given: from 21 cts. in Los Angeles to $2.35 in Chicago. The work is that of the seventh and eighth grades.

| | *No. of pupils.* | *Cost per pupil.* |
|---|---|---|
| Cleveland, O. | 900 | .25 |
| Toledo, O. | 1095 | .68 |
| Springfield, Ill. | 225 | 1.40 |
| Chicago, Ill. | 4231 | 2.35 |
| Minneapolis, Minn. | 1108 | .40 |
| Carthage, Mo. | 60 | .25 |
| Los Angeles, Cal. | 2005 | .21 |
| Columbus, Ga. | 200 | .30 |
| Hampton N. & A. Inst. | 24 | .33 |
| Homestead, Pa. | 120 | .40 |
| Baltimore Polytechnic Institute | 279 | .41 |
| Carlstadt, N. J. | 35 | 1.00 |
| Montclair, N. J. | 80 | .30 |
| Newark, N. J. | 975 | .33 |
| Red Bank, N. J. | 90 | .25 |
| Concord, Mass. | | 1.00 |
| Berkeley School, N. Y. | 31 | 1.35 |
| Milton, Mass. | 85 | .45 |
| Natick, Mass. | 60 | 1.00 |
| Lewiston, Me. | 138 | .70 |
| Average cost per pupil | | $ .67 |
| 10% depreciation on equipment | | $45.60 to 79.74 |

An efficient and economical provision for manual training equipment in the upper grammar grades is the establishment of manual training centres. These centres may consist of either one or two rooms in a school building or a separate building erected solely for manual training. The centre accommodates the pupils of a district comprised within a certain radius. In such an arrangement the manual training work is usually placed either during the first or last period of the school session, thereby causing a minimum loss of time in going and coming between the regular school and the manual training shop. For example, a pupil enrolled for the first morning period would report for manual training at nine o'clock, the same as at his regular class room. He then loses only the time required to make the journey back to his regular school after he has had his work in manual training. Again, the boy having manual training during the last morning period goes direct to his home, thereby losing only the time required to reach the manual training school.

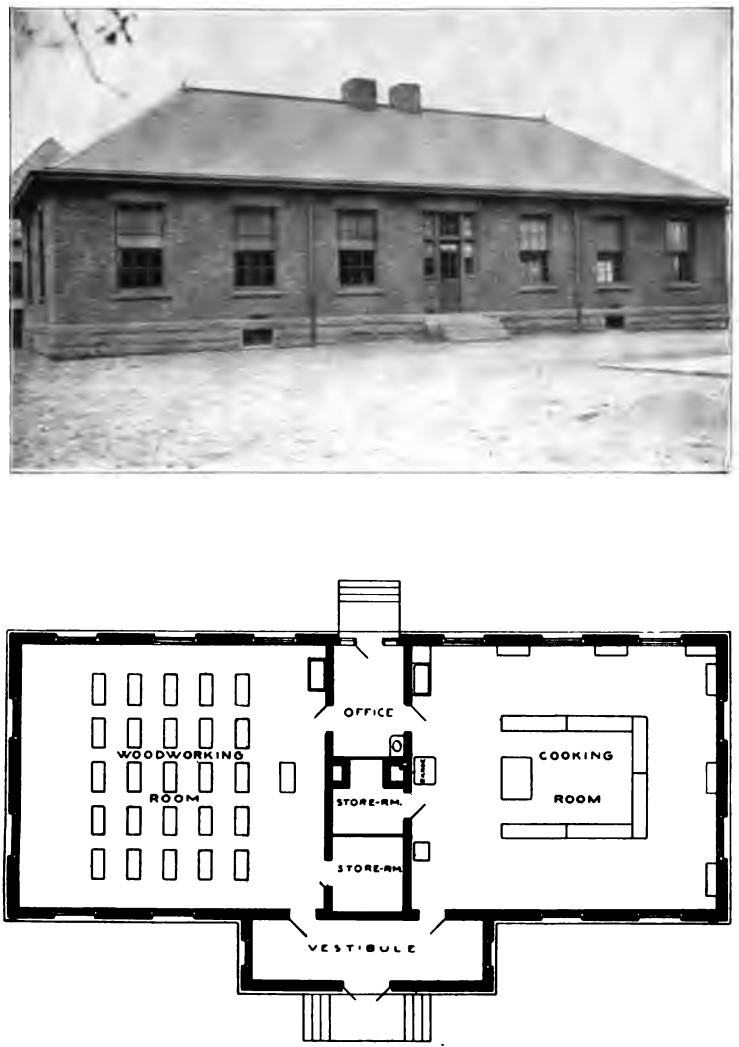



Fig. 7. Wade Park Manual Training Centre, Cleveland, Ohio.

A type of center installed in a special building is found in the Wade Park Manual Training School, of Cleveland, Ohio, an illustration and plan of which is shown in Fig. 7.

The cost of the building and equipment is given below:

| | | |
|---|---|---|
| | Building, including mason and cut-stone work, carpenter work, painting, glazing, plumbing, gasfitting, sewers, heating and ventilating, galvanized iron work, tin and slate roofing, blackboards, and all extra work on building | $4548.00 |
| 27 | benches | 135.00 |
| | Tools | 120.03 |
| 52 | stools | 23.83 |
| 7 | cooking school tables | 65.00 |
| | Case for dishes | 8.25 |
| 5 | cases for caps and aprons | 130.00 |
| | Dishes | 47.39 |
| | Gas and coal ranges | 44.75 |
| | Toweling, etc. | 9.98 |
| | Office desk | 8.75 |
| 6 | chairs | 6.00 |
| 2 | teacher's tables | 9.00 |
| | Sundries, estimated at | 30.00 |
| | | $5,185.98 |

The building is equipped to accommodate from 600 to 700 boys and girls, under the direction of two teachers. The pupils are divided into thirty classes, fifteen classes in wood work and fifteen in cooking. Each class works one period of one and one-half hours each week.

The cost of supplies, wood, drawing-paper, cooking materials, etc., averages about twenty-five cents per pupil per week.

## HIGH SCHOOL

The first-year class in the high schools requires much the same equipment as above and usually does the same general line of work, though more advanced in character. The cost per pupil for maintenance appears to be about $1.00 as will be seen from the following list:

Fig. 8. Wood Turning Equipment, Pratt Institute, Brooklyn, N. Y.

Fig. 9. Demonstration Theatre, Mechanic Arts High School, Boston, Mass.

| | *No. of pupils.* | *Cost per pupil.* |
|---|---|---|
| Pratt Institute | 96 | 1.00 |
| Lewis " | 48 | 1.00 |
| Concord, Mass. | | 1.00 |
| Natick, Mass. | 60 | 1.00 |
| Indianapolis, Ind. | 135 | 1.10 |
| Champaign, Ill. | 75 | .40 |
| Binghamton, N. Y. | 110 | .40 |

*Bibliography.*—1, 3, 4: 9–30, 8, 10, 17: 34–48, 22: 75–85, 26, 31, 34, 41, 42, 45: 77–108, 46, 47, 48, 58, 59, 64, 68, 69, 74: 1–172, 80, 83, 85, 86: parts, 87, 88: 98–100, 103–109, 126–131, 93: parts, 94, 96: 31–91, 98, 99, 100, 101, 106, 107, 112: Book II, 29–54, 113, 114, 118, 119, 120, 121: 116–197, 122, 123, 124, 125, 133, 134: parts, 135, 138, 16 Plates, 139, 140, 141, 145, 147, 152, 154: 136–147, 255, 256, 155, 156.

WOOD TURNING AND PATTERN MAKING is generally introduced in the second year of the high school course. In addition to the joinery equipment, lathes and lathe tools are required. We are here confronted with a large item of expense not heretofore met with; that of power. This may be furnished either by an engine on the premises supplying power direct or through a dynamo and motors, or it may be furnished through motors driven from an outside supply of current. An eight-horse power, vertical, automatic cut-off engine costs about $200. A seven and one-half horse power electric motor costs about $250. Shafting, pulleys, couplings, hangers, of which more or less are required according to conditions, may be calculated at fifty per cent. less than list prices as given in the catalogue of a reliable dealer. Belting costs about eight cents per inch foot.

A comprehensive tool equipment for each lathe is as follows:

| | |
|---|---|
| Turning gouges, ½ inch and ¾ inch | $ .54 |
| Flat turning chisels, $^{8}/_{16}$ inch and ¾ inch | .62 |
| Round-nose chisels, $^{5}/_{16}$ inch and ⅝ inch | .47 |
| Square chisels, ¼ inch and 1 inch | .42 |
| Parting tool, $^{8}/_{16}$ inch | .37 |
| Paring gouges, ½ inch and 1 inch | .94 |
| Washita oil-stone | .49 |
| " slip stone | .03 |
| Pair 6-inch calipers | .61 |
| Oil can | .20 |
| Dust brush | .23 |
| Rule | .10 |
| Total cost of tools for each lathe | $5.02 |

| | |
|---|---|
| 24 sets of tools @ $5.02 | $ 120.48 |
| 24 lathes @ $45 | 1080.00 |
| Pulleys (estimated) | 60.00 |
| Belting (estimated) | 90.00 |
| Shafting, hangers and couplings (estimated) | 100.00 |
| Cost of addition to joinery equipment | $1450.48 |

A power-driven band saw can be had for $65.00, or a foot-power jig-saw for $20.00. If a circular saw is added to the equipment for use in cutting up stock its cost would be about $175.00.

Fig. 10. Foundry Equipment, Pratt Institute, Brooklyn, N. Y.

*Maintenace.* — Returns from eleven schools give an average of $1.62 per pupil as the cost of material, 10% loss and depreciation of equipment, $143.55.

*Bibliography.*—4: parts, 17: 48–51, 40, 50: 179–214, 86: parts, 88: 131–132 96: 92–102, 122: 199–241, 138: 14 plates.

FOUNDRY WORK sometimes occupies part of either the second or third year of the high school course. It requires a special

room, preferably situated in the basement. The estimate furnished below is for an inexpensive equipment. With this equipment castings may be made in white metal or lead. Where practicable a brass melting furnace may be added to this equipment, thus allowing for castings in brass or bronze. A more complete equipment, capable of furnishing castings in iron would require a cupola, with its accessories; an expensive and generally impracticable installation.

*Equipment for class of twenty-four students*

| | | |
|---|---|---|
| | White metal furnace and blower | $ 58.00 |
| | Core oven | 50.00 |
| 24 | sand troughs | 72.00 |
| 24 | small flasks | 15.00 |
| | Ladles, skimmers, etc. | 10.00 |
| | Sand bins and shelves | 30.00 |
| 24 | student sets consisting of: Rawhide mallet, 4-inch trowel, ½-inch Yankee slicker, ½-inch double-end slicker, parting sand duster, draw spike, brass gate cutter, swab-pot and swab, 16-inch mesh sieve, pair of rammers, soft brush, 2-foot straight edge, short-handled fire shovel, and 7-inch bellows for each two students, @ $9 per set. | 216.00 |
| | Total cost of equipment | $451.00 |
| | Double crucible furnace | 100.00 |
| | Cupola | 500.00 |

*Maintenance.*—If white metal or lead is used these materials can be remelted and used. Molding and core sand must be provided, but can be reused, thus making the cost per pupil dependent upon the amount of waste and the cost of running the fire for the furnace. When lead or white metal is used and remelted this cost may come to perhaps 20 cents per pupil. If a cupola is used the expense per pupil, exclusive of depreciation, may reach as high as $1.20.

Ten per cent loss and depreciation of equipment, $45.10, or $105.10 on a cupola plant.

FORGE SHOP WORK is also best located in a well-lighted room on the ground floor. A typical equipment for a class of 24 students is as follows:

Fig. 11. Forge Shop, Overhead Exhaust Piping, Pratt Institute, Brooklyn, N. Y.

Fig. 12. Forge Shop, All Piping Underground, Stout M. T. School, Menomonie, Wis.

| | | |
|---|---|---|
| | Pressure and exhaust fans, with shafting, etc. | $450.00 |
| | Piping, etc. (estimated) | 300.00 |
| | Hand drill | 20.00 |
| | Bench vise | 5.50 |
| | Swage block | 5.00 |
| | Bar shear | 25.00 |
| 6 | blacksmith vises | 27.60 |
| 24 | forges, with water and coal boxes. | 384.00 |
| 24 | anvils | 216.00 |
| 24 | tool stands | 24.00 |
| 24 | sets of tools (as follows): 1½-pound hammer, hot chisel, one each; ⅜-inch and ⅝-inch top and bottom swages, ⅝-inch top and bottom fuller, poker, ¼-inch top and bottom fuller for each eight students, pair of pick-up tongs, pair each of ¼-inch, ⅜-inch, ½-inch, ⅝-inch and ¾-inch, tool tongs, fire shovel, rake, 12-inch steel square, pair of 6-inch calipers, pair of 6-inch dividers for each six students, centre punch, ¼-inch and ⅜-inch punch, ⅜-inch and ⅝-inch bolt-heading tool, set hammer for each three students, flatter for each three students, sledge for each four students, and cold chisel for each eight students, @ $11.00 per set | 264.00 |
| | Total cost for equipment | $1721.10 |

The piping is a very variable item, depending upon the situation of the forges in relation to the fans. In the case of a single-story room being used, it is thoroughly practical to arrange the exhaust flue for direct discharge through the roof without the use of an exhaust fan. In a number of cases the pressure piping has been laid below the floor of the forge room and in some instances the exhaust piping has been similarly disposed of.

*Maintenance.* — The cost of Cumberland coal, Norway iron, tool steel, and sheet iron, used in typical courses, appears from a number of returns to be in the neighborhood of $2.00 per pupil.

Ten per cent loss and depreciation of equipment, $149.61.

*Bibliography.* — There are a number of trade works on forging and foundry practice that are not given below, but which would be of interest and use to teachers in this line. The references here given are only to distinctively manual training books.

4: 46–48, 30: 258–309, 43, 96: 112–123, 108, 109: 175–239, 122: 242–275.

Fig. 11 shows a forge shop fitted with the overhead system of exhaust, and Fig. 12 a shop fitted with the underground system.

MACHINE SHOP.—The most advanced work in manual training is that of the machine shop, often given in the last year of the high school course. The equipment is the most expensive used in the manual training school. Power, either electric or steam, must be provided. The course generally consists of bench-work in chipping and filing, and of machine work. The equipment for each will be considered separately.

Fig. 13. Machine Shop, High School, Hartford, Ct.

*Equipment for bench work for class of twenty-four students*
*For each student*

| | |
|---|---|
| Vise | $7.00 |
| 3/16-inch square file, 6-inch | .08 |
| Flat bastard file, 12-inch | .17 |
| Hand second-cut file, 12-inch | .22 |
| " " " 3-inch | .11 |
| Smooth file, 7-inch | .10 |
| Half-round bastard file, 10-inch | .15 |
| " second-cut file, 5-inch | .09 |

| | |
|---|---|
| Pillar file, 6-inch | .09 |
| Taper saw file, 6-inch | .06 |
| 1-pound hammer | .45 |
| File card | .08 |
| 4-inch spring dividers | .31 |
| 3-inch steel scale | .32 |
| 4- " " square | 2.00 |
| Centre punch | .11 |
| Scriber | .12 |
| Cold chisel | .09 |
| Cape " | .15 |
| Round-nose chisel | .11 |
| Pair of copper vise jaws | .75 |
| Total for individual equipment | $12.56 |
| Benches, with drawers, for 24 pupils (estimated) | $192.00 |
| 24 individual equipments | 301.44 |
| Total equipment for bench work | $506.00 |

The equipment for machine shop work varies greatly in different schools. There is little question but that a very large amount of money has been unnecessarily expended for such equipments in manual training schools mainly from the fact that some traditional precedent has been followed and much larger and more expensive tools installed than are needed or indeed adapted to the natural possibilities of this work. The following tools represent something like the fundamental necessities for such an equipment. The prices quoted are those prevailing at the present writing and are subject to fluctuation.

| | |
|---|---|
| 6 engine lathes, 10-inch swing, 4-foot bed, friction countershaft, rise and fall rest, @ $118.00 | $708.00 |
| 3 6-inch Sweetland combination chucks (with reversible jaws), @ $13.00 | 39.00 |
| 16-inch x 16-inch x 3-foot planer, with Newell vise | 533.00 |
| 12-inch drill press, with capacity to drill 1¼-inch hole, automatic feed | 118.00 |
| 10-inch x 4-foot speed lathe | 45.00 |
| Grindstone and trough, with turning device | $25.00 to 85.00 |
| | $1,528.00 |

Such an equipment would provide a separate tool for eight or even nine workers. It is possible to give the instruction upon

these tools in conjunction with the less expensive bench work by placing a portion of the class at the tools while the others are working at the bench and rotating until all have had both tool and bench experience. Such an arrangement, however, gives but limited opportunity for the machine tool instruction and a larger number of such tools is desirable if the classes are of the usual size. The above set of tools, with the exception of the grindstone, may be multiplied to the extent of providing individual tools for the class, or some of the following tools, which are arranged perhaps in the order of desirability, may be added.

| | |
|---|---|
| 14-inch engine lathe, 6-foot bed, friction countershaft, taper attachment | 310.00 |
| 12-inch combination chuck, reversible jaws | 22.00 |
| No. 2 Browne & Sharpe universal milling machine | 675.00 |
| No. 1 sensitive drill press | 70.00 |
| No. 2 B. & S. tool grinder, with cutter grinding attachment, | 175.00 |
| Shaper | 270.00 |
| | $1,522.00 |

*Lathe tools for each student*

| | |
|---|---|
| Diamond point tool | $ .48 |
| Round nose " | .48 |
| Side " | .48 |
| Parting " | .48 |
| Thread " | .48 |
| Centre punch | .11 |
| Pair of 4-inch spring calipers | .31 |
| Pair of 4-inch inside calipers | .27 |
| 6-inch steel scale | .60 |
| Centre gauge | .20 |
| Lathe dog, ½, ¾, 1, and 1½ | 1.52 |
| | $5.41 |

In addition to the above items, machine shop equipments comprise numerous small tools, almost too many to consider in detail, and varying in quantity and kind. The following is a quite complete working list for a class of 24:

| | |
|---|---|
| Morse twist drills: 1 set Nos. 1 to 60; 1 set $\frac{1}{16}$ inch to $\frac{1}{2}$ inch; 1 each, $\frac{17}{32}$ inch, $\frac{9}{16}$ inch, $\frac{19}{32}$ inch, $\frac{5}{8}$ inch, $\frac{21}{32}$ inch, $\frac{11}{16}$ inch, $\frac{23}{32}$ inch, $\frac{3}{4}$ inch, and $\frac{25}{32}$ inch; 2 each, $\frac{13}{16}$ inch, $\frac{7}{8}$ inch, $\frac{29}{32}$ inch, and $\frac{15}{16}$ inch; Nos. 1, 17, 20, 36 and 46; 6 each, $\frac{31}{32}$ inch and $\frac{1}{4}$ inch, Nos. 6, 16, 24, 25, 29, 31, 33 and 43; 12 each, $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, and $\frac{3}{8}$ inch; 24 of $\frac{33}{32}$ inch, and 12 $\frac{35}{32}$ inch centre drills | $26.74 |

| | |
|---|---|
| Reamers: chucking, ¼ inch to 1 inch by 16ths.; centre, 2-¼ inch; hand reamers, ¼ inch to 1 inch by 16ths.; Morse taper, Nos. 1 and 2; Morse taper roughing, 2 each of Nos. 1 and 2 | 45.79 |
| Mandrels, ¼ inch to 1 inch | 8.27 |
| 2 drill gauges | 3.25 |
| 3 scratch gauges, 5 inches, grad. | 2.25 |
| Inside lock-joint 6-inch calipers | 1.05 |
| Outside " 8 " " | 1.34 |
| 2 universal bevels, 3 inches | 2.56 |
| Depth gauge, 4 inches | .64 |
| Double square, with bevel blade, 4 inches | 1.41 |
| Level, 12 inches | 1.50 |
| 2 hack-saw frames, 8 inches | 1.54 |
| 3 surface gauges, 8 inches | 4.50 |
| 5 No. 19 micrometer calipers, with friction attachment, @ $4.70 | 23.50 |
| No. 30 micrometer caliper, with friction attachment | 7.25 |
| Vernier caliper, 6 inches, eng. | 12.75 |
| 12-inch bevelled steel straight edge | 1.70 |
| " steel rule, No. 1, grad. | 1.07 |
| " steel rule, No. 4, grad. | 1.07 |
| " hardened steel try-square | 8.50 |
| 4-inch key seat rule | 2.13 |
| Test indicator | 12.75 |
| Surface plate, 14 inches x 18 inches | 26.70 |
| ⅞-inch exterior and interior cyl. gauge | 4.00 |
| 2 ball peen hammers, 12 ounces | 1.08 |
| 2 " " " 6 " | 2.16 |
| 2 small riveting hammers | .60 |
| Steel figures, $^1/_{16}$ inch, $^3/_{32}$ inch, and ⅛ inch | 1.80 |
| " alphabet, $^3/_{32}$ inch | 1.80 |
| Soldering set | 1.90 |
| 50-inch tape | 2.85 |
| 6 knurl handles | 1.50 |
| 1 dozen assorted knurls | 5.40 |
| Goodell breast drill, No. 6 | 2.60 |
| " hand " " 5 | 2.25 |
| Coes' wrenches, one 6 inches; three 8 inches and 12 inches | 1.77 |
| 4 rawhide mallets, No. 2 | 1.88 |
| Babbit hammer | 1.25 |
| 2 steel screw clamps, No. 6 | 4.45 |
| 2 clamp dogs, No. 1, 6 of No. 2, and 2 of No. 3 | 8.18 |
| Hand taps, 1 set ¼ inch to ¾ inch | 10.16 |
| Machine screw taps, one 14 x 24, three each 3 x 48, 10 x 32, and 12 x 24, and two each 6 x 32, 8 x 32, 10 x 24, and 14 x 20 | 3.40 |

| | |
|---|---|
| Machine screw dies, one each 3 x 48, 10 x 32, 12 x 24, and 14 x 36; and two each 4 x 36, 6 x 32, 8 x 32, 10 x 24, and 14 x 20 | 2.80 |
| Round die set, No. 9B | 9.00 |
| Adj. round dies, No. 2, ¼ inch to ½ inch | 4.00 |
| Nichols' tap wrenches, Nos. 00, 0, 1, and 2 | 4.75 |
| Total for small tools | $276.84 |
| Equipment for bench work | $506.00 |
| " of individual machine tools for class of 24 $4,500 to | $5,000.00 |
| Pulleys, belting, and shafting | 450.00 |
| Equipment of lathe tools | 129.84 |
| " " other " | 276.84 |
| Total equipment for class of 24 | $6,362.68 |

Fig. 14. Dressmaking Room, Pratt Institute High School, Brooklyn, N. Y.

*Maintenance.* — The average cost per pupil for material, based upon returns from several typical schools, is $2.00 to $4.50.

To this must be added the proportionate part of a 10 per cent. equipment depreciation dependent on the number using the shop.

*Bibliography.* — The same remarks hold here as given under the "Forging" bibliography above.

4: parts, 30: 215–258, 96: 124–145, 109: 1–175.

DRESSMAKING. — Sewing in the earlier grades has been considered on page 8. The equipment for the higher grade work varies but little from that given for the lower grade work, and the cost of maintenace averages the same. In the high school the equipment requires special rooms.

The work of the high school usually consists in the drafting and making of garments.

I. Comprehensive equipment.

*Equipment for class of fifteen girls*

| | | |
|---|---|---|
| (1) Drafting and Dressmaking room: | | |
| 8 tables | | $60.00 |
| Mirror | $15 to | 20.00 |
| Pedestal | | 6.50 |
| Screen | | 8.00 |
| 1 gas stove, 3 burners | | 5.00 |
| Connections to stove | | 2.00 |
| 8 irons—4 heavy and 4 long narrow | | 2.00 |
| Wardrobe | $25 to | 40.00 |
| 15 chairs | | 30.00 |
| 15 high stools | | 7.50 |
| Clothes tree | | 3.50 |
| 5 sewing machines | $150 to | 275.00 |
| 4 ironing boards | | 4.00 |
| Board for curved seams | | .90 |
| 15 boxes for materials | | 1.05 |
| Paper roll holder | | 5.00 |
| 18 yard sticks | | 4.28 |
| 18 tape measures | | .83 |
| 18 scissors | | 5.25 |
| 3 bust forms | | 1.50 |
| 2 skirt " | | 6.00 |
| | $338.31 to | $483.31 |
| (2) Sewing room — to accommodate 30 pupils: | | |
| Roll front case for materials for 90 pupils | | 50.00 |
| Tables to accommodate 30 pupils | $30 to | 80.00 |
| 30 chairs | | 60 00 |
| 30 footstools | | 60.00 |
| 36 boxes (6 large and 30 small) | | 4.20 |
| Demonstration frame | | 2.00 |
| | $206.20 to | $256.20 |
| Total cost of equipment I. | $544.51 to | $749.51 |

II. Cheaper equipment for 15 in dressmaking and 30 in sewing.
Dressmaking and sewing room combined:

| | |
|---|---|
| 8 tables, 5-foot kitchen | $22.56 |
| (An even less expensive table arrangement may be obtained of boards supported on saw-horses, when the two kinds of work are practiced in the same room. A convenient plan for the dressmaking tables is to have these hinged to the wall, so as to drop down when not in use.) | |
| 30 chairs @ $7.50 per doz. | 18.75 |
| 1 stove (3 burners) and tubing | 3.75 |
| 6 irons | 1.50 |
| 4 ironing boards | 3.60 |
| Wardrobe . . . . . $5.00 to | 20.00 |
| Mirror | 12.00 |
| 4 sewing machines . . . . $120.00 to | 220.00 |
| Screen | 3.00 |
| 18 yard-sticks | 4.28 |
| 33 scissors (3 of them buttonhole) | 9.40 |
| 6 large boxes @ .35 | 2.10 |
| 30 small " @ .07 | 2.10 |
| Total cost of equipment II. | $323.04 |

*Maintenance.* — Average cost of maintenance for the work in the high school, if the pupils furnish their own garment materials, is about twelve cents per pupil.

*Bibliography.*—2, 5, 6, 11, 15, 16, 20, 21, 23, 24, 25, 38, 39, 50, 51, 52, 70, 71, 72, 73, 81, 93: parts, 104, 115, 116, 128, 131, 142, 153.

COOKING is very often taught in the seventh and eighth grades or both and in the high school. A specially equipped room and a special teacher are required.

*Equipment.* — In laying out a cooking equipment provision should be made for a kitchen equipment, a dining-room equipment and a store room.

### *Kitchen Equipment*

The tables used for cooking should be from 30 in. to 33½ in. in height according to height of pupils and should provide 25 in. to 33 in. width for each pupil according to size. The tables may be arranged in the laboratory in the form of a continuous

horseshoe, in parallel lines or as single tables. (Figs. 15 to 20, inclusive.) Shelves, drawers and cupboards are provided in the body of the tables for the storage of utensils and materials.

The materials used for covering the tops are various, including wood, plain and metal-covered, slate, marble, and tile. Of these, unglazed, vitrified white tile laid over asphalted paper and bound at the table edge by a metal strip is perhaps the best, although somewhat expensive.

Arrangements for individual cooking either in the form of single or double-burner gas stoves or stands with Bunsen burners are provided where not prohibited on account of cost. When gas is not available, a reliable single-burner oil stove may be used for each pupil.

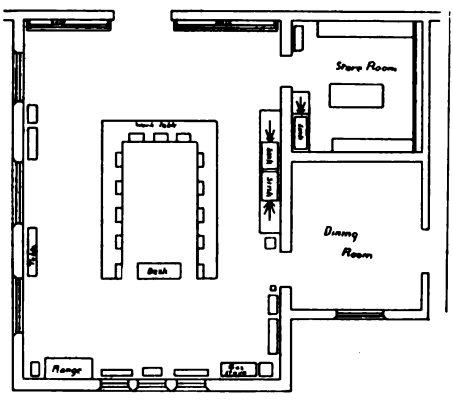



Fig. 15. Plan showing Horseshoe Arrangement of Cooking Tables.

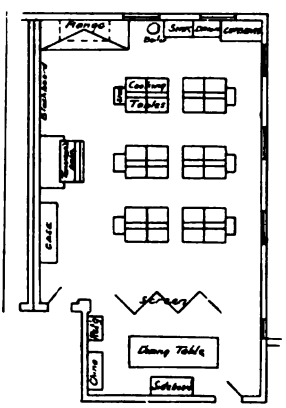



Fig. 19. Plan showing Group Arrangement of Cooking Tables.

| | | |
|---|---|---|
| Table for fifteen pupils, with drawers for provisions and materials; cupboard, closed with roll-front, sliding board, and tiled top made of quartered-oak, about . . . | | $500.00 |
| Table for fifteen pupils, with one drawer for each pupil, made of Georgia pine, white pine or stained whitewood, from | $150 to | 250.00 |
| Kitchen tables may be used where funds are extremely limited, but are not advisable, about . . . . . | | 30.00 |
| Individual stove equipment for tables . . | $25.00 to | 75.00 |
| Coal or gas ranges . . . . . | 14.00 to | 32.00 |

Fig. 16. Cooking Laboratory, Horseshoe Arrangement, High School, Hartford, Ct.

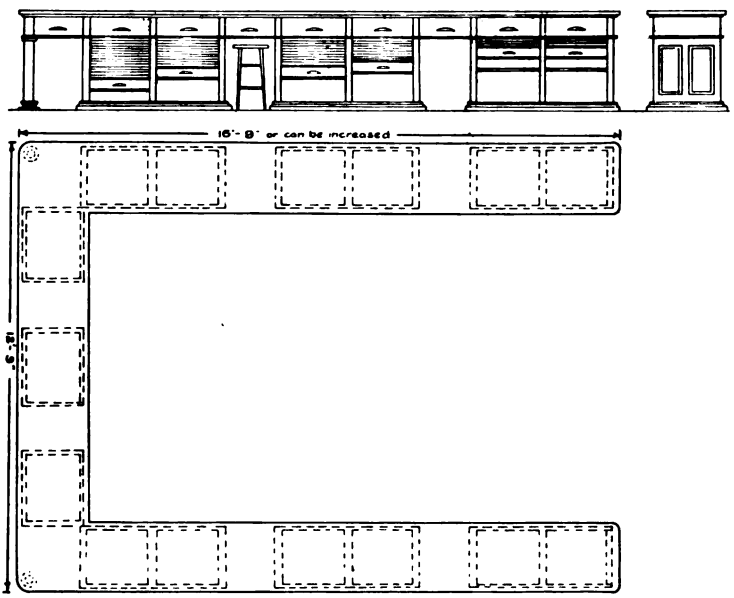



Fig. 17. Plan of Continuous Cooking Table.

### *Utensils*

The prices quoted are subject to a considerable discount in purchasing by the dozen.

*Two for each pupil*

| | |
|---|---|
| Bowl, 1 pint, earthen or granite | $ .06 |
| Teaspoon, nickel or aluminum | .11 |
| Towel, 1 yard long, crash | .16 |
| | $ .33 |

*One for each pupil*

| | |
|---|---|
| Baking-dish, 1 quart, earthen or granite | $ .08 |
| Bowl, 4-quart, earthen or granite | .20 |
| Bread-board, small, wood | .20 |
| Dish-cloth or mop | .10 |
| Egg-beater, medium, wire or iron | .10 |
| Frying-pan, small, iron | .15 |
| Kitchen-fork, steel, wood handle | .05 |
| " knife, " " " | .05 |
| Mat, 8 inches square, linoleum | .05 |
| Pepper-shaker, glass | .10 |
| Plate, granite or tin | .15 |
| Salt-shaker, glass | .10 |
| Salt-spoon, bone | .05 |
| Saucepan, with cover, 1 pint, granite | .18 |
| Tablespoon, nickel or aluminum | .14 |
| Vegetable brush, small, wood back | .05 |
| Vegetable knife, steel, wood handle | .10 |
| Measuring-cup, ½ pint, block tin | .10 |
| | $1.95 |

*One for each two pupils*

| | |
|---|---|
| Biscuit-cutter, block tin | $ .06 |
| Bread-pan, medium, block tin | .17 |
| Colander, medium, block tin | .32 |
| Double boiler, 1 or ½ pint, block tin or granite | .50 |
| Flour dredger, block tin | .10 |
| " sifter (revolving handle), block tin | .22 |
| Grater, medium, block tin | .10 |
| Nutmeg grater, block tin | .08 |
| Potato-masher, wire, wood handle | .09 |
| Rolling pin, wood | .06 |
| Scrubbing brush, large, wood | .10 |
| Skimmer, small, block tin | .09 |
| Strainer, medium, block tin | .12 |
| Teapot, 1 pint, earthen (Japanese) | .25 |
| Thermometer | .75 |
| | $3.01 |

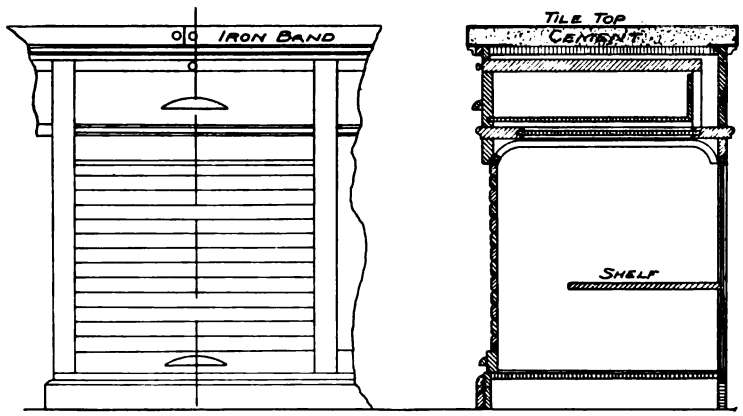



Fig. 18. Detail of Fig. 17.

Fig. 20. Laboratory with Group Tables, Manual Training High School, Indianapolis, Ind

*Three or four for class of twelve*

| | |
|---|---|
| Apple-corer, block tin | $ .05 |
| Chopping-knife, steel | .50 |
| " tray, wood | .40 |
| Coffee-pot, 1 quart, granite or tin | .35 |
| Japanned tray, medium | .45 |
| Mixing spoon, large, wood | .05 |
| Muffin pan, 12 in a pan, block tin | .15 |
| Pitcher, 1, 2, and 3 quarts, earthen | .36 |
| | $2.31 |

*Two for a class of twelve*

| | |
|---|---|
| Cake pan, medium, block tin | $ .25 |
| Double boiler, 3 pints, granite | 1.14 |
| Griddle, medium, soapstone | 1.12 |
| Griddle cake turner, iron | .10 |
| Kettle, 6 quarts, granite | 1.86 |
| Lemon squeezer, glass | 1.05 |
| Saucepan, 2 quarts, granite | .69 |
| Strainer, 3 pints, block tin | .25 |
| Toaster, wire | .10 |
| | $6.56 |

*One for a class of twelve*

| | |
|---|---|
| Bread knife | $ .50 |
| Can opener | .10 |
| Coffee mill | 1.12 |
| Corkscrew | .10 |
| Egg beater (Dover), large, iron | .10 |
| Fruit jars, 1 dozen, 1 quart, glass | 1.12 |
| " " " 1 pint, " | .75 |
| Frying-kettle, large, iron | 1.82 |
| Funnel, medium, block tin | .15 |
| Ice-cream freezer (Packer's standard), 3 quarts | 2.25 |
| Jelly glasses, 1 dozen | .50 |
| Knife sharpener | .55 |
| Larding needle | .20 |
| Measure, 1 quart, block tin | .20 |
| " 1 pint, " " | .05 |
| Meat broiler, medium, iron | .50 |
| " knife | .20 |
| Pot chain | .07 |
| Pudding mold, 3 pints, block tin | .30 |
| Scales, to 10 pounds | 2.25 |
| Skimmer, large, tin | .10 |
| Steamer, medium, block tin | .55 |
| Tea-kettle, large, iron, granite, or aluminum | .50 |
| | $13.98 |

### *Utensils for housework*

| | |
|---|---|
| Blacking brush | $ .05 |
| Broom | .25 |
| Cheese-cloth duster | .10 |
| Dust brush | .10 |
| Dust pan | .15 |
| Floor brush | .75 |
| Lamp cloths | .10 |
| Mop | .25 |
| Pail, indurated fibre | .27 |
| Scrubbing brush | .24 |
| Whisk broom | .10 |
| Window cloths, etc. | .10 |
| | $2.46 |

### *Store Room Equipment*

| | |
|---|---|
| Bread cloths | $ .10 |
| 6 crocks, large, earthen | 2.40 |
| 6 " medium, " | 2.00 |
| 4 flour pails, wood | 2.00 |
| Ice bag, 1 yard, duck | .15 |
| 1 dozen jelly glasses, with covers | .30 |
| 6 2-quart Mason jars, for coffee, etc., glass | 1.20 |
| Strainers, 5 yards, cheese-cloth | .25 |
| " 1 yard, flannel | .20 |
| Cupboards, for provisions, utensils, and dishes | $20.00 to 50.00 |
| Refrigerator, medium size, to fit available space | $15.00 to 20.00 |
| | $43.60 to $78.60 |

### *Dining Room Equipment*

| | |
|---|---|
| Canton flannel cloth | |
| 1 dining-table and 6 chairs | $20.00 to 32.00 |
| 2 tablecloths and napkins | 10.00 |
| Enough dishes for setting table and serving a simple meal | 10.00 |

(It is advisable to buy dishes that come in "open stock," for if any are broken, they can be easily replaced. If setting of the table is not taught, a few dishes for the pupils will answer the purpose; say, for each, a cup, saucer, and plate; and 4 vegetable dishes, 2 bread plates, and 2 platters.)

| | |
|---|---|
| Knives, forks, spoons, glasses, etc. | 20.00 |
| | $60.00 to $72.00 |

(If a sideboard is added, the cost would be about $28.00 additional.)

*Summary of cost of equipment to accommodate twelve pupils at a time*

Kitchen equipment

| | |
|---|---|
| Tables with cupboards, etc., stools, stoves, range, and sink | $550.00 to $650.00 |
| Utensils (as per detailed statement) | 85.87 |
| Store room equipment | $43.60 to 78.60 |
| Dining room equipment | $60.00 to 72.00 |
| Total cost of equipment | $739.47 to $886.47 |

*Maintenance.* — In reports received but few estimates of the cost of maintenance for cooking lessons were given. Toledo, O., and Binghamton, N. Y., each gave the cost per pupil at 75 cts.; Cleveland, O., at 25 cts., and Indianapolis, Ind., places the figures at $2.36, but adds, "The average per capita for the cooking laboratory given above includes the cost of coal, ice, and laundry. Deducting these, the cost of food material per pupil per lesson was two cents and nine mills." The report from the Adams Cooking School (a centre for nine schools in seventh and eighth grade cooking) in Minneapolis, shows an enrollment of 337 pupils, and the cost of material for the year as follows:

| | |
|---|---|
| Groceries | $107.03 |
| Meat | 18.71 |
| Milk | 17.45 |
| Utensils, towels, soap, etc. | 15.33 |
| Total | $158.52 |

320 lessons were given at an average cost of 49½ cents per class lesson, or $0.147 per pupil per lesson. Cost per pupil per year, 47 cents. At the Madison Cooking School (a centre for eight schools) the enrollment was 302 and the cost of supplies $105.13, making the cost per pupil 35 cents.

*Bibliography.*—4: 7–8, 35, 62, 90, 110, 111, 149, 150, 151: parts, 154: parts.

LAUNDRY. — Few schools have a laundry equipment. The cost of equipping and maintaining a laundry in connection with school work is here given in order that the subject of this paper may be covered as fully as possible.

The work may be given in the same room as that used by the class in cooking or a separate room may be fitted up. In the latter case stationary tubs may be used in place of the portable ones. To these must also be added a laundry stove, water-heating arrangement, and suitable plumbing. In the former case there should be a large closet provided for the storage of tubs, etc. About the walls of this closet there should be shelves for the work of the class. The following estimate is based on the plan of having the laundry work done under conditions involving a minimum expenditure of space and money:

Fig. 21. Laundry Equipment.

*Equipment for class of eight pupils*

| | |
|---|---|
| Large fibre tub | $ .83 |
| Double boiler, for starch | 1.03 |
| Teakettle | .97 |
| 12 small fibre tubs | 7.20 |
| Small fibre pail | .20 |
| Granite soap cooker | .65 |
| Yellow earthenware bowl, 1 quart | .12 |
| " " " 2 quarts | .16 |
| " " " 4 " | .25 |
| 8 yellow earthenware bowls, 1 quart | .40 |
| 2 tin measuring cups | .20 |
| 6 tablespoons | .48 |
| 6 teaspoons | .30 |
| Knife | .10 |
| Wooden spoon | .05 |

| | |
|---|---|
| 100 feet of clothes line | .90 |
| Clothes pins | .10 |
| Towel roller | .10 |
| Skirt board covers | |
| 10 yards unbleached cotton cloth | .80 |
| 4 " cotton felting, 54 inches | 2.00 |
| 1 yard white flannel | .40 |
| Safety pins | .25 |
| 3 roller towels (7½ yards linen toweling) | .88 |
| Dish pan, 14 quarts | .63 |
| Universal wringer, large | 4.25 |
| 2 universal wringers, small | 5.00 |
| Tin dipper | .20 |
| Oval clothes basket | 1.25 |
| " boiler | 1.25 |
| 6 4-foot benches | 5.40 |
| 8 4½-foot skirt boards, with adjustable supports | 12.00 |
| 8 small wash-boards, two-thirds usual size | 3.00 |
| 2 clothes-horses (4 feet high, 4 folds) | 1.76 |
| Fringe brush | .63 |
| 3 soft brushes | 1.14 |
| 3 whisk brooms, for sprinkling | .54 |
| 4 flat irons, 7 pounds | 2.20 |
| 8 " " 5 " | 2.56 |
| 8 " " 4 " | 3.20 |
| 4 " " 3 " | 1.40 |
| (Cheaper irons may be had at 4 cents per pound.) | |
| 8 Troy polishers | 3.60 |
| 8 iron stands | .40 |
| 8 " holders (asbestos) | .32 |
| Total cost of equipment | $69.10 |

*Maintenance*

| | |
|---|---|
| 3 dozen Ivory soap | $1.50 |
| Starch | .30 |
| Bluing | .25 |
| Beeswax | .40 |
| Borax | .20 |
| Ammonia | .20 |
| White vine vinegar | .10 |
| Salt | .05 |
| Total cost of maintenance | $3.00 |

Cost per pupil, 37½ cents.

*Bibliography.* — **18, 66, 92, 111**: parts, **152**: 287–314, 401–407.

Fig. 22. Mechanical Drawing Room, showing adjustable tables, High School, Hartford, Ct.

Fig. 23. Mechanical Drawing Room, showing table with drawers, Pratt Institute, Brooklyn, N. Y.

MECHANICAL DRAWING may begin in the seventh grade and may continue through the high school course. In the seventh and eighth grades it may be made part of the regular shop course. On page 18 a drawing kit is given as a part of the bench equipment to meet this condition.

In the high school a separate room is required, for which the following is a typical equipment.

| | |
|---|---|
| 24 adjustable drawing stands, @ $8.00 | $192.00 |
| 24 drawing boards, @ 72 cents | 17.28 |
| 24 stools, @ 75 cents | 18.00 |
| Locker and drawing-board case | 100.00 |
| Case for the storage of drawings, etc. | 100.00 |
| Blackboard | 10.00 |
| Various drawing models | 50.00 |
| Total cost of equipment | $487.28 |

If instruments are furnished by the school an additional amount of about $4 per pupil should be added.

*Maintenance.* — Instruments, pencils and erasers to be furnished by the pupils. A good quality of drawing paper costs one cent a sheet, 11 in. x 15 in. Allowing for waste, this brings the cost per pupil to between 50 cts. and 75 cts. An average from the reports received gives 63 cts. per pupil as the cost for mechanical drawing.

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Room accommodations for high school manual training with its requirement of special shops and laboratories is of course an extremely important element of expense. Such accommodations generally assume one of three typical forms: a separate building especially designed for shop purposes and containing no recitation rooms located within easily accessible distance from the main

Fig. 24. Rindge Manual Training School, Cambridge, Mass.

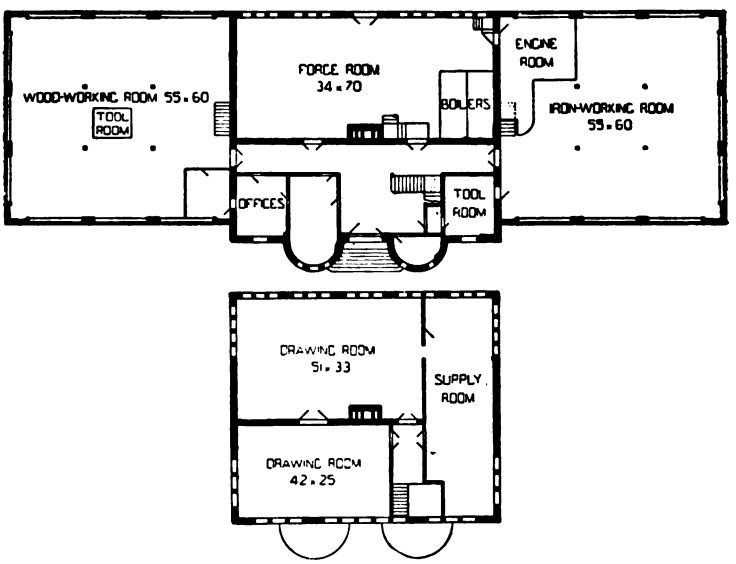


Fig. 25. Plan of Rindge Manual Training School, Cambridge, Mass.

building; a building especially designed for a manual training school and containing recitation rooms as well as shops, the latter so disposed (generally in wings) as to secure the greatest amount of light and at the same time to minimize the effect of noise; and finally a building in which the shops occupy such space in the general plan as is most expedient and convenient without special regard to isolation.

Floor plans and views showing examples of each of these types are illustrated in Figs. 24 to 30, inclusive.

Fig. 26. Manual Training High School, Kansas City, Mo.

Fig. 27. Mechanic Arts High School, Boston, Mass.

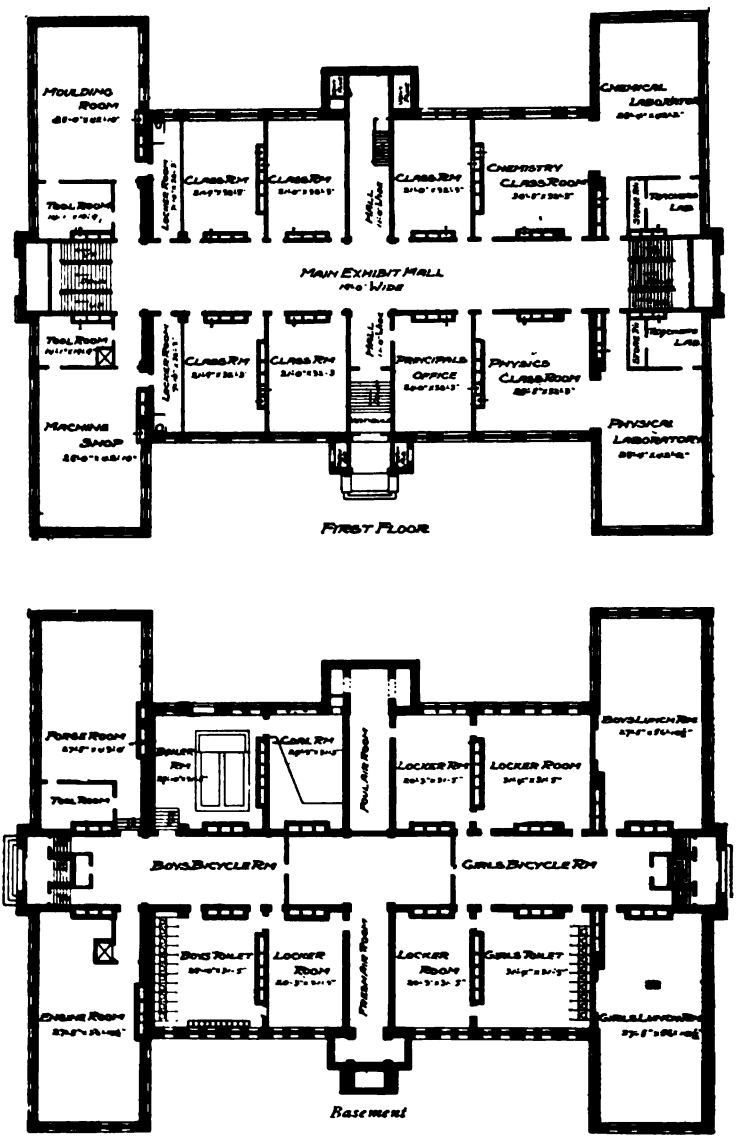


Fig. 28. Plan of Manual Training High School, Kansas City, Mo.

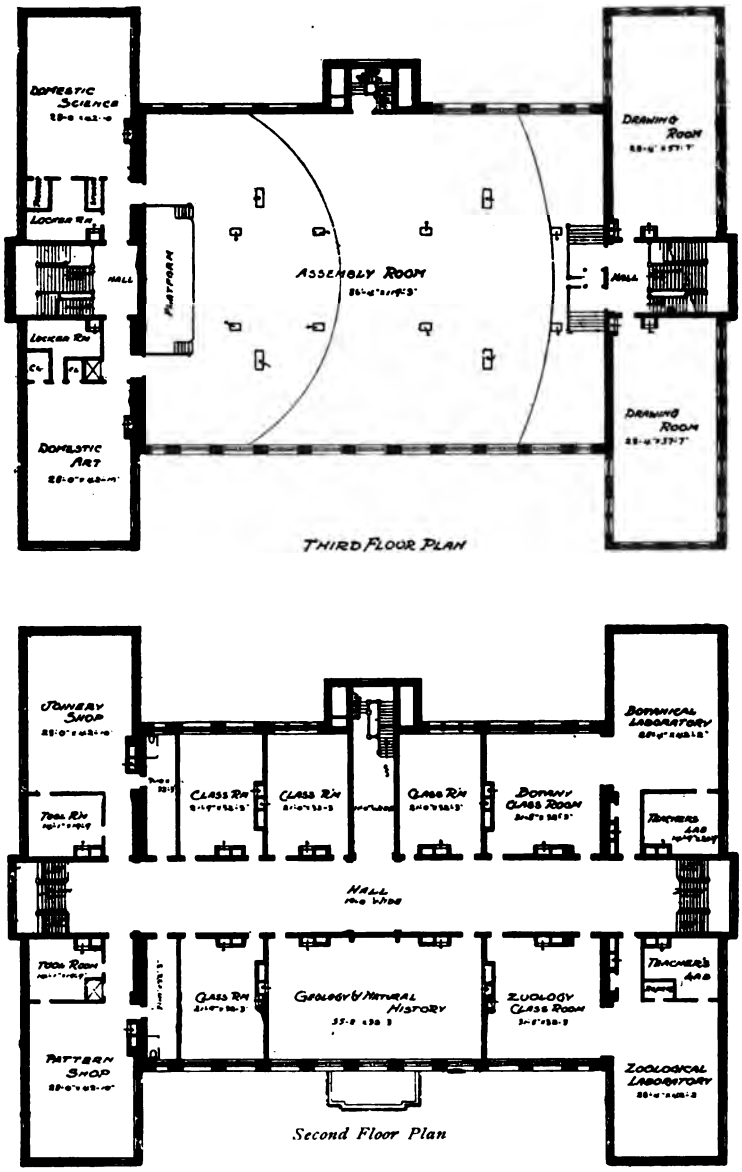


Fig. 29. Plan of Manual Training High School, Kansas City, Mo.

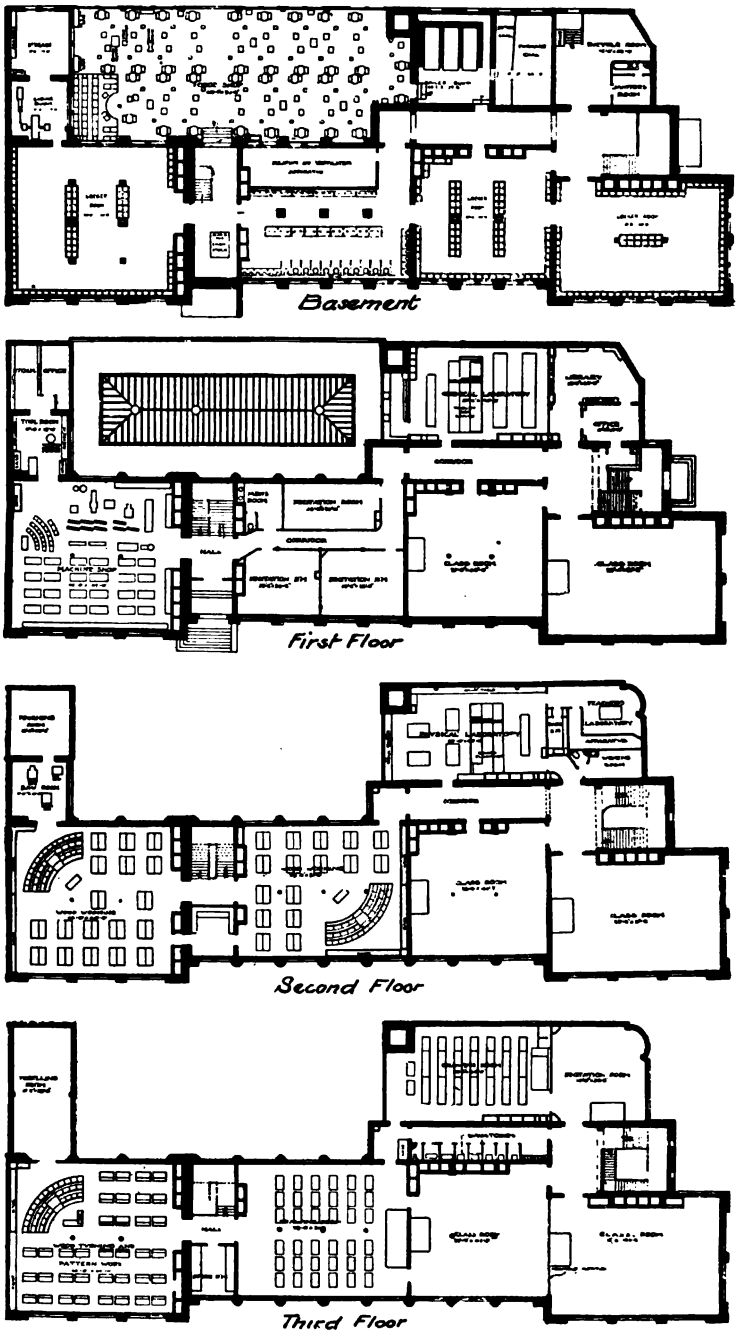


Fig. 30. Plan of Mechanic Arts High School, Boston, Mass.

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